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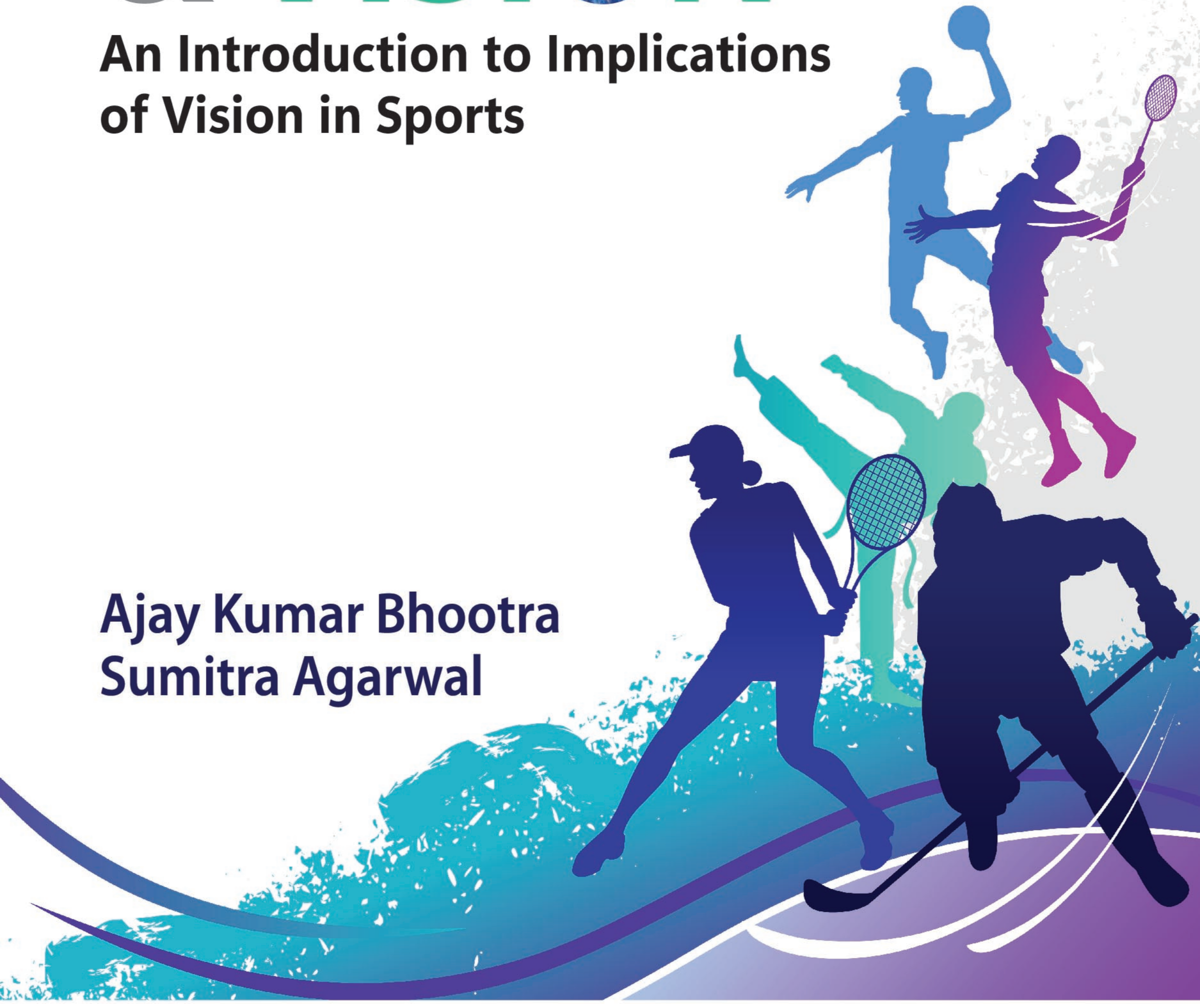
A Manual of *Elite* SPORTS & VISION

An Introduction to Implications of Vision in Sports



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Sumitra Agarwal

2nd Edition

JAYPEE

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Visual Demands in Sports

4 CHAPTER

Sports are highly visually demanding occupations. Athletes and players continuously take in visual inputs regarding the ball, other players and the surroundings, process the information to react, respond by moving hands, feet and body and finally complete visual task either by catching ball, hitting or throwing ball, kicking or punching the opponent. In the process, every facet of visual system plays is involved.

Athletes and players need sharp central vision to detect subtle movements, details, or changes in the environment. This is vital in sports like shooting, archery, and even activities like rock climbing.

Athletes need to maintain intense focus for extended periods. Visual concentration is required to block out distractions and stay attuned to the game or competition. This is essential in sports like gymnastics and figure skating.

Judging distances and depths accurately is essential in sports. Athletes need to assess the position of objects in their environment to make quick and accurate decisions. This skill is crucial in sports like golf, archery, and soccer.

Being aware of what's happening in the periphery is important in team sports. Athletes must be able to monitor the entire playing field or court while focusing on specific tasks. This is particularly important in sports like football and basketball.

Many sports require precise hand-eye coordination. Athletes need to accurately track moving objects, such as a ball or opponent, and coordinate their movements accordingly. This is crucial in sports like tennis, baseball, and basketball.

Sports often require split-second decision-making and rapid reactions. Athletes need to process visual information quickly and respond accordingly. This is evident in sports such as boxing, fencing, and hockey.

Athletes must predict the path of the object and position themselves accordingly. Following the trajectory of a fast-moving object, such as a ball or puck, is crucial in sports like cricket, baseball, and hockey.

Recognizing patterns and anticipating opponents' moves is crucial in strategic sports like chess, as well as in team sports where players need to understand the patterns of play.

Every facet of visual system is involved in the visual process. Understanding the implications of each facet is critical to develop a sport-specific visual profile for a specific sport and then identify the visual skill weaknesses for remediation and enhancement therapy. **Figure 4.1** shows the different facets of vision that are critical to understand to establish a comprehensive sport-

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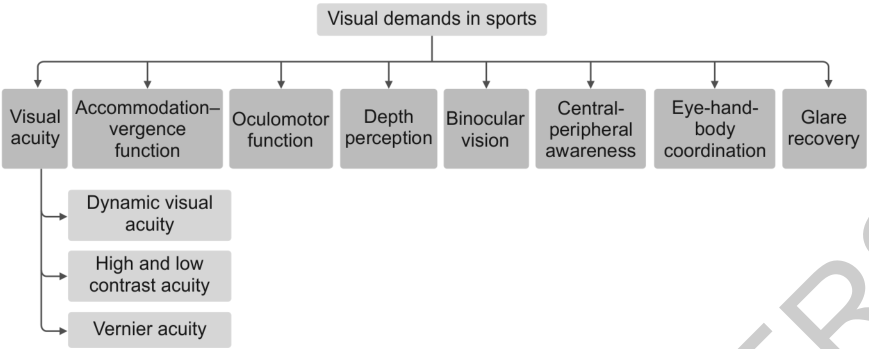

Fig. 4.1: Different facets of visual skills.

specific visual profile, targeted remediation and enhancement therapies to address specific weaknesses.

VISUAL ACUITY

Visual acuity is the spatial resolving capacity of the visual system, which affects aiming ability of the athletes. It is most commonly measured statically, and is therefore, also referred to as Static Visual Acuity (SVA). Visual acuity of an individual person depends upon host of factors which can be grouped under physical and physiological factors. Physical factors may be said to include those factors that directly or indirectly affect light and light transmission and thus influence the retinal image. Physiological factors are linked to an individual person. A broad level discussion on all factors can be done on several heads as shown in **Figure 4.2**.

- The object size and the object distance are the foremost important factor that determines the visual acuity of an individual. The physical size of the object and its distance from the eye determines the visual angle. The objects situated closer create larger visual angles compared to those at a greater distance. Similarly larger objects create larger visual angle. Therefore, the combination of object size and distance determines the clarity and detail with an individual can perceive visual stimuli.
- The ability to perceive fine details is intricately linked to the intensity of illumination falling on the observed object. While the eye can detect faint sources and movements in comparatively low light conditions, recognizing intricate details necessitates sufficient illumination. Engaging in tasks that demand precision, such as reading or fine work, in inadequate lighting

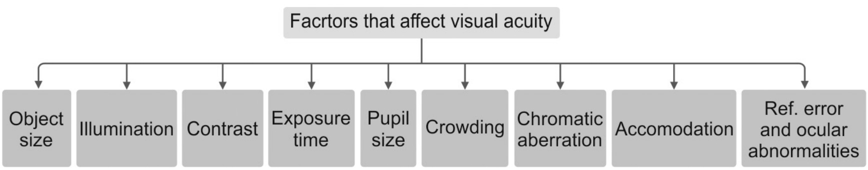

Fig. 4.2: Factors that affect visual acuity.

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can result in eye strain or headaches. Notably, visual acuity experiences an initial improvement with increased luminance of the observed object, reaching a point known as the ceiling effect. Beyond this threshold, further adjustments in illumination yield diminishing returns in terms of acuity enhancement. Understanding and optimizing these factors contribute to maintaining optimal visual acuity in various contexts and activities.

- Vision is intricately linked to contrast sensitivity, underscoring the significance of clear distinctions between objects and their backgrounds. In situations where the contrast between an object and its background is low, compensatory measures, such as enlarging the object, may be necessary to achieve comparable levels of visual acuity. Understanding and managing contrast in the visual environment are key elements in optimizing visual acuity for various visual tasks and activities.
- The impact of exposure time on an individual's visual acuity is a subject with limited available evidence. However, it holds practical significance, particularly in the context of dynamic visual acuity, where either the object under observation, the observer, or both are in motion. Generally accepted is the notion that dynamic visual acuity tends to decrease when the exposure time or duration of observing an object is shorter.
- The size of the pupil plays a crucial role in determining visual acuity. A larger pupil allows more light to stimulate the retina, reducing diffraction, but it can be impacted by aberrations in the eye, affecting resolution. Conversely, a smaller pupil minimizes optical aberrations but limits resolution due to diffraction. Optimal visual acuity is often achieved with a mid-size pupil, typically ranging from 3 mm to 5 mm, striking a balance between diffraction and aberration limits.
- The interaction between two closely positioned objects can diminish visual acuity. This phenomenon, known as crowding, is frequently observed in individuals with amblyopia or severe maculopathy. Crowding imposes a fundamental constraint on conscious visual perception and hinders object recognition across the entire visual field.
- Using monochromatic light rather than white light is expected to yield a clearer image by eliminating the impact of chromatic aberrations.
- Form sense, predominantly governed by cones, is most acute at the fovea due to a higher concentration of cones, which diminishes rapidly towards the periphery. In the peripheral retina, cone sensitivity decreases, while rod sensitivity increases.
- Accommodation is crucial for achieving spatial resolution at different distances from the eye. A young emmetrope with an intact accommodative reflex can effectively perform visual tasks that involve depth scanning.
- Visual acuity may be influenced by factors such as refractive error, corneal curvature abnormalities, ocular media opacities, and axial length. Additionally, psychological elements like fatigue and malingering can also impact visual acuity.

In sports, visual acuity significantly impacts the ability to discern crucial visual cues, such as a bowler's hand grip or the trajectory of a ball in the air,

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and to fixate on the target. The fundamental principle is that clear visibility of the target enables effective fixation; conversely, if one is not looking directly at something, visibility is compromised. Good visual acuity, indicative of strong foveal vision, is particularly vital for precise aiming in sports.

In the sporting context, visual acuity is influenced by various factors, including:

- Target size and distance.
- Speed of the target.
- Speed of the athlete.
- Contrast of the target against its background.
- Color of the target and background.
- Ambient light level.
- Position of the luminaries.
- Precipitation and wind speed.
- Reflectivity of the playing surface and surroundings.
- Environmental distractions like rain, mist, fog, etc.

DYNAMIC VISUAL ACUITY

In the realm of sports, events are predominantly characterized by motion, involving either the athlete or the object in motion. This raises the argument that static visual acuity alone does not provide an accurate representation of visual acuity demands. To truly assess visual acuity, it is crucial to determine the Dynamic Visual Acuity (DVA) threshold. Dynamic visual acuity is defined as the ability to resolve details when there is relative movement between the observer and the test object.

The measure of visual acuity during relative motion between the object and the observer is termed as Dynamic Visual Acuity (DVA). Given the dynamic nature of most sports, DVA emerges as a potentially important variable in sports performance. Notably, there exists a modest correlation between Static and Dynamic Visual Acuity, with DVA showing a significant decrease as target velocity increases.

However, the measurement of dynamic visual acuity is not commonly incorporated into routine optometric examinations. While various research groups have endeavored to develop suitable tests for dynamic visual acuity, standardization remains limited. Nevertheless, there is a consensus that DVA is influenced by several factors:

- Poor static visual acuity makes it unlikely for dynamic visual acuity (DVA) to be satisfactory, and significant individual differences in DVA are noted among subjects with similar static visual acuity.
- DVA is influenced by learning, with practice enhancing DVA. Athletes engaged in dynamic sports often exhibit superior dynamic visual acuity.
- Fixation accuracy on a moving object involves the coordinated efforts of saccades, pursuits, vestibular ocular reflexes, and vergences to maintain a steady image on the fovea.
- Deterioration in DVA is observed with reduced contrast between the stimulus and its background, impacting static acuity.

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- Dynamic visual acuity experiences a notable decline with increased target velocity during tracking movements.
- Males tend to have slightly higher dynamic visual acuity than females.
- Dynamic visual acuity deteriorates more rapidly with age compared to static visual acuity.
- Athletes in dynamic sports may develop enhanced dynamic visual acuity through consistent practice.
- Deficits in static visual acuity can hinder the perception of small objects or subtle facial expressions, while deficits in dynamic visual acuity affect timing, distance judgment, and the detailed observation of objects, such as discerning the spin of a ball.

Dynamic visual acuity (DVA) tests are designed to minimize variables by restricting either the target's or the subject's motion. When limiting target motion, subjects are encouraged to move their heads at a specific frequency, although precise measurement of this movement may be challenging. Alternatively, restricting target motion offers better control and monitoring possibilities.

It is important to note that DVA is linked to the efficiency of the entire visual system, with the oculomotor system playing a crucial role. Various eye movements contribute to this process. Smooth pursuit eye movements ensure the continuous foveation of the target during tracking. Saccadic catch-up, employed alongside the pursuit system, helps maintain foveation of the target. The vestibular ocular reflex, working in conjunction with saccades and pursuit eye movements, compensates for head, body, and external movements to preserve the retinal image. Clear vision is achieved when a precisely focused image of the object of regard is centered on the fovea, and accurate oculomotor skills maintain this relationship.

Dynamic visual acuity is intricately connected to the efficiency of the entire oculomotor system, where eye movements play a pivotal role. The eyes can accurately follow a target in motion up to a maximum velocity of approximately 40 degrees per second. Smooth pursuit eye movements ensure the ongoing foveation of the target during tracking, but beyond angular velocities of 40 degrees per second, accurate tracking becomes challenging.

Saccadic catch-up, working in conjunction with the pursuit system, is employed to maintain the foveation of the target. Saccades, characterized by ballistic movements, can be used to foveate intervals of a target trajectory, even at angular velocities reaching up to 1000 degrees per second.

Additionally, the vestibular ocular reflex collaborates with saccades and pursuit eye movements to compensate for head, body, and external movements. This reflex ensures the maintenance of a stable retinal image despite changes in the external environment.

HIGH AND LOW CONTRAST ACUITY

Sports take place in dynamic environmental conditions that impact visual performance by influencing contrast levels. Factors such as rain, sleet, haze,

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air pollution, indoor lighting, darkness, stadium lights, glare, bright sun, and overcast conditions all contribute to variations in contrast between the target and its background, consequently affecting visual performance.

Contrast sensitivity, as demonstrated by several studies, offers valuable insights into functional or real-world vision that may not be fully captured by a visual acuity test alone. Therefore, combining low-contrast acuity with high-contrast visual acuity provides clinicians with a more comprehensive understanding of an individual's actual visual functioning in real-world scenarios.

In various clinical scenarios, contrast sensitivity can be compromised even when visual acuity remains normal. Conditions such as refractive surgery, capsular opacification of lenses, oxidative changes due to heavy smoking, multiple sclerosis, and diabetes without significant retinopathy, cataract, age-related maculopathy, or corneal edema can lead to a reduction in contrast sensitivity.

In the context of sports, the dynamic and ever-changing environment poses challenges to discriminating objects, creating potential inaccuracies in the information processed by the brain. The velocity of object movement also adversely affects contrast sensitivity, indicating that high-speed scenarios demand higher levels of visual skills. Deficits in contrast sensitivity can impact an athlete's ability to pick up visual cues on the field, causing delays in reacting to a tennis ball or negotiating snow undulations while skiing. For instance, tracking a white ball against a light blue sky presents a low-contrast environment, underscoring the significant impact of contrast sensitivity on athletic performance.

The use of low-contrast charts proves to be more informative in assessing these scenarios. Athletes quickly recognize the relevance of measuring vision at low contrast, as it reflects real-life conditions such as poor lighting, fading sun, mist, rain, and dirty kit. Performance deficits at low contrast can be significant, even when high-contrast vision is reasonably good. Subtle visual deficiencies may not be apparent at high contrast, particularly under favorable lighting conditions. Disproportionate worsening of visual acuity at low contrast is usually indicative of an issue with the visual system, emphasizing the importance of low-contrast acuity in relation to real-life sports conditions.

VERNIER ACUITY

Vernier acuity serves as an alternative method for gauging potential vision. It pertains to the accuracy with which an individual can assess the alignment of targets, such as determining whether two spots are vertically aligned. Vernier acuity essentially involves the "recognition of relative position". During the test, the subject is prompted to evaluate the offset between two parallel lines, using both eyes and each eye individually. The test employs targets with progressively decreasing displacements until the subject can no longer differentiate the displacement. Vernier acuity for a subject is defined as the smallest visible offset between stimuli that can be detected. The precision of

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observations in vernier acuity testing improves with an increase in the time allowed for observation.

Vernier acuity, also known as hyperacuity, is associated with several important characteristics:

- Vernier acuity is considered a visual cortical function rather than a retinal function.
- The accuracy of alignment in Vernier acuity is relatively resistant to optical blur. Consequently, it has been observed that Vernier acuity remains unaffected by image degradation, such as defocus or blurring, as well as motion and changes in luminance.
- Misalignments detected in Vernier acuity testing are often smaller than the diameter and spacing of retinal receptors.
- Vernier acuity is susceptible to practice effects and changes in attention. Following training, observers' thresholds have been demonstrated to improve significantly, up to six-fold.
- In peripheral vision, Vernier acuity decreases more rapidly than grating acuity.

The clinical significance of Vernier acuity lies in its ability to assess macular function in individuals with compromised optics. For instance, patients with cataracts may exhibit good Vernier acuity even in the presence of reduced normal visual acuity. This highlights the integrity of the macula, particularly when obtaining a clear view of it is challenging.

In the realm of sports, Vernier acuity holds particular relevance, especially in target sports. It contributes to understanding the visual system's mechanisms in achieving a high degree of accuracy. The Vernier acuity test simulates the target as seen through a rifle foresight, illustrating how fine judgment can be impacted by poor vision. While not a diagnostic measure of visual performance, it opens opportunities for discussion when athletes discover a significant reduction in their Vernier acuity.

ACCOMMODATION-VERGENCE FUNCTION

In the context of sports, the ability to focus clearly and rapidly on objects of regard, whether stationary object like the foresight or rear sight of the rifle while shooting or moving object like a football is crucial for athletes. Any deficit in the eyes' ability to accommodate can lead to increased effort in focusing and tracking objects, potentially slowing down response times and affecting performance, especially during long competitions where fatigue can impact the focusing muscles of the eyes.

Vergence, also known as eye teaming ability or binocularity, refers to the coordinated movement of both eyes in opposite directions to achieve or maintain single binocular vision. In sports, speed, accuracy, and sustained fusional ability are essential. For instance, quick fusional flexibility is necessary in sports like ice hockey, where players need to track fast-moving pucks. Conversely, long sustained fusional flexibility is critical in golf, where players repeatedly shift focus between the ball and the hole on the putting

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green. Convergence insufficiency has been seen as a cause of late braking in Formula 1 racing, resulting in excessive speed going into corners. In chess because of the intense concentration, the players have the tendency to be esophoric. In sports like snooker, long-sustained vergence facility is vital as players constantly need to converge onto the cue stick, cue ball, and target hole.

Accommodation and vergence functions are closely linked. Changes in focus automatically trigger changes in vergence and accommodation, known as the accommodation-vergence reflex. Accommodation vergence facility facilitates the eye's ability to focus clearly and accurately at different distances, relying on good oculomotor control and cognitive ability.

Accommodation and vergence functions have a great bearing on the fundamental visual skills of aiming and anticipation. In tennis, the player who is serving needs to focus on the immediate target and then on the opponent's position at the opposite end to place his shot. The receiver, on the other hand, has to focus on the server's racket, his body movement, and then the fast-approaching ball. The player has to have the ability to shift focus rapidly throughout the contest, even when general body stamina is running down due to heavy work. Poor focusing ability will severely affect anticipation. Downhill Skiing is a fast sport, and it requires fast eyes. Shifting of focus from far to near, from infinity to intermediate distance, must be efficient. As the skier becomes aware of the terrain in front and at the gates, other skiers, and trees, slow shifting of focus will delay processing for quick decision-making. The demand increases with higher speeds and more difficult terrain. In table tennis, the accommodative mechanism has to work very fast as the athlete quickly shifts his focus from near to far or intermediate targets throughout the contest. In rifle shooting, good vision is important in lining up the gun's sight with the target. There are four things in the equation: the aiming eye, the rear sight, the front sight, and the target. The participant peeps through the sights and sees three circles. He has to align these circles concentrically with the target in the middle. Unlike pistols, it is important to have a clearer picture of the sights than the target in rifle shooting. Once the shot is released, the shooter must maintain the sight picture for a few seconds. A follow-through is needed to be able to see what possible errors occurred during the release of the shot.

Accommodation is the ability to change focus from near to far and vice versa. Vergence is the ability to rapidly and accurately fuse the two images from two eyes into one image when focus is changed from near to far (divergence) and from far to near (convergence). The two eyes work as a team to maintain this in all directions of gaze and also when focus changes from point to point. Any deficit in this ability, slowness or slackness, can lead to double vision, impede anticipation and reaction time, and thereby affect the performance of the athlete.

Accommodation facilities facilitate the speed of the eye to focus clearly and accurately at different distances, which depends on good oculomotor control and cognitive ability. In modern sports, downhill skiers travelling at a speed

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of up to 80 mph and ice hockey players trying to hit a small, dangerous puck develop eye speed to almost superhuman levels. It, therefore, appears that fast eyes and fast sports go together.

Physiologically, eye muscles are the same as leg muscles, and the physiochemical responses underlying their activity are similar. The extraocular muscles are also under the same hormonal influence as the other skeletal muscles, but they are isolated from the external rigors of training and normal physical development. The speed of muscles decreases with age, which reduces their accommodative ability. In fact, skeletal muscles are very adaptable. Their efficiency can be improved and maintained by various exercises.

OCULOMOTOR FUNCTION

Oculomotor skills are the neuromuscular control skills developed to point the visual system on the target and move it to either follow a moving target or jump from one object to another. Clear vision occurs when a precisely focused image of the object of regard is centered on the fovea and the accurate eye movements or oculomotor skill maintain the relationship. Several components of oculomotor system likes Fixation, Saccades, Pursuit and Vestibular and Optokinetic movements work together to ensure that the vision is clear and stable. Saccades eye movements are abrupt shifts in fixation. The subject may present the history of trouble hitting a ball, or doing poorly in an event, or poor eye-hand coordination. Pursuit eye movement refers to the movement of eye fixating a moving object. Drugs, fatigue, emotional stress and even the test anxiety may adversely affect pursuit. Pursuit eye movement is very important in sports. For example, it would be much more difficult to track a tennis ball accurately if head movements are necessary, because the gross neck muscles are not as efficient as the finely tuned extra ocular muscles. The reflexive vestibular ocular system stabilizes the eyes on a target during head movements. It generates slow eye movement in response to head movements. This is an orientational reflex not requiring visual stimuli. Optokinetic reflexes are essentially slow eye movements in response to image movement.

Fixation is an important consideration during eye movement because the eye has to be static at the end of each saccade as it holds the image of object on the fovea. Fixation needs the combined involvement of all types of eye movements. This is a well-integrated sensory- motor process where the muscles are in dynamic equilibrium. It is interesting to note that even steady fixation is not truly motionless vision, because the eye is subject to microscopic involuntary movements. This allows the retinal image to be refreshed. Any deficits can affect fixation.

In sports the ability to maintain fixation of rapidly moving object is a critical aspect for allowing visual processing of crucial information. It also enables changing fixation from one point to another rapidly and accurately in dynamic sports and is critical to maintain steady fixation in non-dynamic sports like target shooting. The accuracy of ocular alignment of the two eyes

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on a given target depends upon the amount of innervations exerted by each of the six extra ocular muscles in each eye that provides precise depth judgment necessary for successful sporting performance. It is likely that muscle speed decreases with age which may contribute to slower reaction time. The speed and the precision of extra ocular muscles are very important for sporting performance at the elite level. However, the need for it can vary from one sport to another.

Geraint Griffiths has categorically mentioned in his article *'Eye speed, motility and athletic potential'* that fast eyes are associated with fast sports. In modern sports like downhill skiers traveling at a speed of 80 mph and ice-hockey player trying to hit a small dangerous puck, develops the eye speed to almost superhuman levels. Physiologically eye muscles are the same as leg muscles and physiochemical response underlying their activity are similar. The problems with making comparative measurements in thigh muscles is that performance is affected by training, high repetitions which could increase the accuracy of measurement and can cause rapid fatiguing even in trained athletes. The extraocular muscles are under the same hormonal influence as the other skeletal muscles, but they are isolated from the external rigors of training and normal physical development. Therefore, he proposed that extra-ocular muscles would be better comparative measure than any other skeletal muscle. The possibility exists that, supported by the eyes' ability to fixate on measuring points, they could be used to measure speed and so predict athlete potential.

DEPTH PERCEPTION

Depth perception is a crucial skill for anticipating the distance and speed of a target, particularly in sports like tennis and squash. These sports heavily rely on depth perception and binocular visual acuity. These visual components enable athletes to anticipate the direction and velocity of the ball. With this information and proprioceptive feedback from the arm and wrist, players can angle the racket head for an effective return shot. Anticipation, driven by depth perception, precedes aiming in the sequence of actions. Any delay in this process can result in poor timing and is often associated with reduced stereopsis. In cricket it has been seen that when a player in the outfield runs to catch a ball, correct timing depends upon the correct judgement of distance and speed of approach of the ball.

Depth perception affects the anticipation skills of athletes in sports. It involves making spatial judgment regarding the distance and the speed of the ball, teammates, opponents, boundary lines and other objects. Sports like tennis, squash which are predominantly anticipatory are highly dependent on depth perception. The critical visual components in tennis are depth perception and binocular vision. With these two components the player judges the direction and speed of the approaching ball. Using this information and proprioceptive feedback from the arm and wrist, the racket head can be angled for the return shot. So aiming follows anticipation which is the result of

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depth perception. If there is any delay anywhere in between, shot will not be executed in time. So poor timing is also associated with poor depth perception ability.

In table tennis, the player should anticipate the ball trajectory, direction of opponent's stroke and spatial judgment of the ball in a short time. Also peripheral judgment of environment and opponent's pattern of play have to be anticipated. So to accomplish the task successfully the perception of depth has to be of high quality.

Anticipation by depth perception is the primary skill for the batsman who anticipates the speed and direction of ball to hit. The batsman needs to develop the spatial judgment of the ball so that he can time his shot correctly. A delay in judgement will result in delay in executing the shot.

Depth perception is very important to know the spatial location of the ball and judge its relative position and direction of it fall in the air while catching. When a player runs to catch a high ball in the outfield, correct timing depends a lot upon correct judgement of distance and speed of the approach of the ball.

Depth perception is very critical for all positions in football. The spatial position of ball, efficient and accurate perception of speed and direction of ball trajectory determines the timing for eye/hand/body and foot response. The ability to pass the ball out of the reach of a defender and into the goalpost is an example of depth perception skill in football. Often the player needs to anticipate the ball in the air and makes his position accordingly to receive it.

Anticipation by depth perception is also important in highly visually demanding sports like snooker and golf. In snooker, the player focuses at the end of the cue stick, the cue ball and aims the ball at which he is shooting. Then he anticipates the distance from the hole where he intends to pot into. In golf anticipation by depth perception is needed to judge the distance between the ball and the fairway and then between the ball and the hole while putting.

Depth perception is also important in aiming predominant sports like archery as it helps the archer judge the distance of the target and then decides the extent to which the string is to be drawn. The ability allows archers to adjust their aim and determine the appropriate tension on the bowstring. Without accurate depth perception, archers may consistently misjudge distances, leading to inaccurate shots. By honing their depth perception skills, archers can improve their accuracy and performance on the field.

The ability of an athlete to block, hit or avoid a rapidly moving ball is dependent on the ability to anticipate the expected trajectory of the ball. Having quick reflex may not necessarily play a significant role. The sensory input of how quickly the image of the ball moves from eyes to brain is difficult to improve, being predominantly genetic. But how quickly the brain processes the information to the body can be dramatically improved with training. When the motor response time is quickened the athlete has more time to make a decision as to what to do with the ball.

There are various types of tests available for checking stereopsis or depth judgment. In the context of sport vision, the closer we simulate the game type condition, the more effective the results would be. Bassin Anticipation Timer

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is a good test developed to check the anticipation and the depth judgement ability of the athletes. The equipment allows the ability of the athlete to judge the speed of approach of an object to be measured. The ability to judge the distance and speed of a moving object as it approaches requires active accommodation, good vergence facility, visual acuity, binocular coordination which ultimately affects anticipation timing.

BINOCULAR VISION

Binocular vision encompasses the coordinated movement of the eyes and the integration of their respective views, allowing us to perceive depth and engage in detailed visual processing. Sporting performance relies heavily on well-established binocular vision, which not only affects immediate performance but also influences anticipation based on depth judgment. When binocular vision is compromised, athletes may experience a loss of confidence and inhibited muscle development due to inefficient sport participation.

In tennis, for instance, experiments blurring the vision in the non-dominant eye revealed significant impacts on players' ability to accurately hit fast-approaching spinning balls. Dominant eyes can overwhelm non-dominant ones, leading to effectively monocular vision and inhibiting depth perception and anticipation.

Similarly, in aiming sports like shooting and archery, dominant—eye athletes can often shoot without closing their non-dominant eye, as the brain naturally suppresses input from the non-dominant eye. Keeping both eyes open maximizes acuity, contrast sensitivity, depth perception, and peripheral awareness while preventing eye muscle fatigue.

Research conducted by the Sportvision group highlighted a case where an archer's slightly short-sighted dominant eye caused blurred vision during aiming, leading the brain to rely on the non-dominant eye. Unfortunately, the non-dominant eye was misaligned with the peep sight, resulting in shots consistently veering left of the target. This issue was rectified by using a -0.75 D soft contact lens in the dominant eye, restoring clear vision and improving shooting accuracy.

CENTRAL-PERIPHERAL AWARENESS

Central awareness refers to the focused attention on the central part of the visual field, where the primary action or target is located. In sports like archery or shooting, central awareness directs the athlete's attention to the bull's eye or target. It helps in maintaining focus and precision during aiming, ensuring that the athlete's aim remains centered and accurate.

Peripheral awareness involves being cognizant of the environment surrounding one's central focus. It extends beyond the direct line of vision, allowing athletes to remain alert to potential threats or opportunities from the sides. In sports like soccer or basketball, peripheral awareness enables players to anticipate the movements of opponents or teammates, facilitating

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A Manual of *Elite* SPORTS & VISION

This book covers everything from the fundamental of sportvision practice to detailed visual requirements of different sports. It is perfect for optometry students and practitioners, or anyone keen on understanding sportvision optometry.

Salient Features

- Concise yet exhaustive book
- Covers all relevant topics and subtopics thoroughly
- Content is organized logically with a clear structure
- Provides practical guidance and strategies, as relevant to the sportvision practice
- Customized to meet the requirements of professionals, students, or practitioners.

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