A Review of the Essential Visual Skills Required for Rugby: Beyond 20-20 Optometry

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Systematic Review

Keywords: vision, sport vision, visual skills, rugby vision

Posted Date: October 24th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-2175100/v1

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Abstract

Background: Vision is one of the most important qualities required of athletes. It provides players with an ability to perform sport-related drills, as well as applying decision-making skills. In order to accurately measure the visual ability of athletes, it is important to first identify the variety of visual skills involved in the sport, in this case rugby.

Objectives: The objectives of the review novelty are to identify the most important visual skills for rugby. To create a referencing point for future studies to be able to add additional visual skills essential to rugby players.

Methods: An electronic search was conducted to assess the scientific literature relating to the visual skills required for rugby. Only peer-reviewed articles written in English were included in the search. Data on the relationship with match performance, the problem definition or purpose of the study, and the inclusion of a theoretical definition of tactical behavior were extracted.

Discussion: The most important visual skills in rugby are: Visual acuity, Eye tracking, Eye focusing, Depth perception, Hand-eye coordination, Fixation, Fusion flexibility, Visual adjustability and Colour flexibility. Rugby players must pay attention to their teammates' positions, understand the opponent's actions and tactics, handle the ball, analyze the current situation, and predict what will happen.

1. Background

Vision is an intriguing component of human presence, that assists with visual recollections, colour identification, and the translation of visual joints [1]. Society utilize vision in exercise of everyday living, such as driving vehicles, signage translation, photographic memory reviews, and performing house or work-related obligations [1]. The focused objective of vision in sport, is to make improvements of visual physiology and athletic performance. Thus far it is recorded that vision plays an important part in sport performance, which increases psychological, perceptive, and physical capacities [1]. Vision is one of the most important qualities required of athletes. It provides players with an ability to perform sport-related drills, as well as applying decision-making skills and providing action upon the perceived stimuli. Visual skills such as peripheral vision or awareness are essential for success in sport [1]. There are two types of vision training programs: generalised vision training (GVT) and sport-specific vision training (SVT). GVT programs are intended to improve fundamental visual functions (such as depth perception, motion perception, and peripheral vision) [2]. Vision professionals, such as optometrists and ophthalmologists, generally utilize a variety of exercises [2]. Although these professionals often work with people who have visual impairments, the same techniques have lately been employed with athletes in an effort to improve sports performance. SVT research, on the other hand, has been found to lead to task-specific gains in sports performance [3, 4]. The reasoning for implementing GVT is that increasing fundamental components of visual function will result in better performance of perceptual-motor abilities that employ the functions being taught [2].
Visual skills in rugby disentangle an athlete's life by preforming but not constrained to target identification, scanning the opponents playing style, player positioning, reactions to audio-visual signals such as indicating where a ball ought to be played, and most vitally acting the hand-eye as well as foot-eye coordination [5]. Amid the execution of a pass, the player executing the pass must have peripheral awareness, of who's behind him/her. The player will moreover have to have a great speed of acknowledgment of how quick the player that's aiming to get the ball, and how much force the ball should be passed with, to be successfully caught by the expecting recipient [5–7]. In an action such as the line-out, it requires players to have a good hand eye coordination with ball, timing of when to throw and catch, in this process the opponents eye gazes must be used as well as central and peripheral vision to complete the catch. All players require good accommodation facility to prevent knocking the ball, furthermore the backline players require good reflexes for handling the ball, decision-making, saving line breaks with speed judgement, hand-eye/ foot-eye coordination, and accommodation facility [5–7]. Movement in response to stimuli during a game is nearly one of the most significant characteristics of a successful athlete. Athletes that are unable to perform a ball, pass and catch a ball, or to navigate around a rugby field, or respond to a spin ball will fail in their sport [5–7].

Most studies until now only focused on single visual skills in rugby that plays a significant role for sport performance such as accommodation facility, speed of recognition, hand-eye/foot-eye coordination, and visual performance [6, 8–11]. Nowhere in literature is a study that combines all these needed visual skills that is essential to play rugby. In this vein, this review novelly aims to create a referencing point for all future studies, as a starting point in creating a comprehensive list of important visual skills for rugby players. This will assist not only in player talent identification, but also to allow for the development of a sport specific visual testing batteries and exercise programs specifically for rugby players.

2. Methods

2.1 Search strategy

To assess the scientific literature relating to the visual skills required for rugby, an electronic search was undertaken on the following databases: Sport Discuss (1975–April 2022) EBM Reviews, PubMed (1966–April 2022), Current Contents, Science Direct, CISTI Source (1993–April 2022), Cochrane Database of Systematic Reviews, Google Scholar, and international e-catalogues. A keyword search yielded MeSH headings: “visual skills”, “sport vision”, “rugby vision”, “vision in sport”, “depth perception”, “eye-coordination”, “concentration in sport”, “fixation skill”, “focusing on sport”, “speed in rugby”, “reaction time”, “colour discrimination”, “fusion flexibility”, “visual memory”, “contrast sensitivity”; which was fused and exploded. Only peer-reviewed articles written in English were included in the search. Original articles were identified and organized for discussion. The reason for going back so far in literature is to create a comprehensive list of visual skills essential to rugby, as the research in this field is limited.

2.2 Data extraction
3. Results

The current study utilized 80 full text English published papers, utilizing an electronic search. After critical dissection of duplicate papers, 69 published papers in accredited journals remained, of which only 51 matched the criteria to form part of this study.

<table>
<thead>
<tr>
<th>Visual Hardware Skills</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual acuity</td>
<td>Dynamic visual acuity helps players perceive moving objects clearly.</td>
<td>12–15</td>
</tr>
<tr>
<td>Depth perception</td>
<td>Is the ability to judge the distance between player and the ball, teammates as well as the opposing team.</td>
<td>16–19</td>
</tr>
<tr>
<td>Fusion flexibility</td>
<td>Fusion flexibility is essential for the player to rapidly and precisely combine two pictures into one image.</td>
<td>20–24</td>
</tr>
<tr>
<td>Colour sensitivity</td>
<td>Contrast sensitivity aids in picking up the ball in a variety of lighting conditions.</td>
<td>22, 24–25</td>
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<tr>
<th>Visual Software Skills</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye tracking</td>
<td>Rugby players use their eyes to track moving things without moving their head.</td>
<td>26–30</td>
</tr>
<tr>
<td>Hand-eye coordination</td>
<td>Indicates how quickly one physically reacts after seeing an object such as the rugby ball.</td>
<td>18, 20, 31–35</td>
</tr>
<tr>
<td>Eye focusing</td>
<td>Rugby players must pay attention and main focus throughout a game.</td>
<td>14, 20, 36–42</td>
</tr>
<tr>
<td>Peripheral vision</td>
<td>Peripheral vision refers to the ability of an athlete to identify objects in their vision away from fixation.</td>
<td>16, 18, 33, 43–46</td>
</tr>
<tr>
<td>Speed and span of recognition</td>
<td>Players must be able to remember a lot of information, while only quickly scanning the rugby field.</td>
<td>21, 22, 37, 47–49</td>
</tr>
<tr>
<td>Visual response time</td>
<td>The faster a player can react to any set of circumstances, regardless of his or her position on the team.</td>
<td>23, 24, 50–52</td>
</tr>
<tr>
<td>Visual memory</td>
<td>Athletes in numerous sports must absorb and retain a fast-moving, complex image of people and things.</td>
<td>23, 49, 53, 54</td>
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4. Discussion
The most variable of all the senses that determine sports performance is thought to be vision [30]. Vision prevails over information gathered through other sensory systems, and it is considered vital to the proper performance of practically all sports [27]. The utilization of vision and visualization skills are required in rugby. These talents, however, are rarely known as a sports vision skill [33]. Rugby can be visually described as non-static, requiring the athlete to process visual information in motion and changes in visual information on a continual basis, requiring more than an hour of visual attention in a dynamic manner, allowing the athlete to continuously process the game [20]. Despite the difficulty of maintaining balance when moving, the movement's range of vision is constantly disrupted, requiring distance vision, direction positioning, and spatial vision recognition [15].

Even though visual demands vary per sport [55] findings suggest that these visual skills are of importance in varying levels of success in rugby [56]. Although previous research examined the impact of vision on performance, few, if any, of these studies examined outcomes, movement, and cognition. Factors of cognition [57] classifies visual skill as either visual hardware or visual software. As well as visual software [57] defines visual hardware as the physical differences in a person's visual system's mechanical and optometric assets. In addition, Abernethy [57] defined visual software as the cognitive differences that exist in the analysis, selection, and presentation of information, as well as coding and general handling of a person's visual information during a competition or in everyday life training. All visual skills discussed in this review will be classified based on whether they meet the requirements for visual hardware or visual software skills. In this vein, the visual skills were classified as follows; Visual Hardware includes: Visual acuity, Color discrimination, Contrast sensitivity, Eye focusing, Fusion flexibility, Fixation and Depth perception. Visual Software includes: Eye tracking, Concentration, Eye foot coordination, Peripheral vision, Speed & Span of recognition, Eye-body coordination, Visual adjustability, Visual reaction time and Visual memory.

**Visual Hardware**

When it comes to sports vision, visual acuity is one of the most studied visual qualities [12]. Certain academics and therapists have theorized a link between dynamic visual acuity and sports performance [13]. Athletes with dynamic visual acuity can perceive moving objects clearly. Rugby is a sport in which players are always on the move. As a result, in a game, dynamic visual acuity is especially important because even while the players are in motion, this visual approach allows them to see the ball kicking and kicking on the field, passing between players, and returning to its original shape in the opponent's movement [14]. Rugby has the following visual characteristics: non-static, where the task requirements are the needs for visual information in sports, and changes in visual information must be processed continually; continuous, necessitating more than an hour's worth of vision; dynamic, athletes must constantly maintain balance in the game, despite being constantly challenged in sports to maintain balance, the challenger must continue to drive the action in the game; and it involves long distance vision, positioning in the direction, and visual recognition of the space; and it involves long distance vision, positioning in the direction, and visual recognition of the space [15].
Depth perception refers to the player’s ability to accurately judge the distance between them and the ball, teammates as well as the opposing team on the rugby field [16]. This skill helps individuals to perceive images as 3D, the brain combines the two different images from each eye to form one 3D picture indicating if the object is near or far [17]. A player’s ability to judge the rotation of the ball as well as the approaching speed of the opposing team has no substitution. This skill is crucial in sports such as rugby which consists of moving objects, including the ball, teammates, and opponents [18]. In rugby, the players should also know their position relative to their teammates and the ball, because it can be very crowded [19]. The ability to accurately measure the distance and speed of the ball is essential for effective kicking. Having good depth perception allows athletes to monitor the ball approaching as they can place the ball in the right space with ease [19]. Depth perception helps athletes to avoid objects, in-bound and out-of-bounds lines, or other players. No player stays in the same place for an extended period of time, the ball, as well as the player, are constantly moving relative to one another, thus good depth perception is needed [58].

Fusion flexibility is essential for the player to rapidly and precisely combine two pictures into one image while maintaining the image’s uniqueness while gazing in different directions [22]. This visual capacity is necessary for avoiding double vision and for judging direction and distance when following other players and the ball [23]. If a player can strengthen his mental image without generating double vision, he will be able to notice holes and opponents more quickly. Without becoming disoriented by what he/she sees in his/her head and what is actually in front of him/her [23]. Player with Fusion flexibility will be able to rapidly recognize the ball as it goes through space [20]. Visual adaptability tests rugby players’ ability to swiftly change and lead their body's motor reflexes [24]. The player's movement reaction will be more predictable and consistent if the player's visual system can adjust to changing demands throughout games [21].

Contrast sensitivity is the visual system's capacity to process temporal and spatial information and distinguish between an object's backdrop and other nearby objects [38]. is a valuable instrument for measuring visual sensitivity to objects of various sizes and contrasts [59]. Contrast sensitivity aids in picking up the ball in a variety of lighting conditions [22]. The contrast between the item and its backdrop tends to be lessened when there is insufficient light, fog, or glare [24]. Color is used in sports to differentiate and mark out athletes who wear colored uniforms [60]. Athletes' performance might benefit from speedy glare recovery, especially during night sports conducted under artificial lights [61]. It will also assist them to distinguish between opposition players, and the referees [53]. This characteristic is related to contrast sensitivity, but it is particular to contrast sensitivity, such as when a rugby player must swiftly identify the rugby ball in the air against a background of sky (blue sky, overcast, and the lights etc) [15]. A unique component of rugby is the choosing of the best filter for the present light levels and surroundings [15].

Visual Software
Eye tracking allows players to shift their eyes to track moving things without moving their head, which allows for a more effective manner of seeing, and it also aids equilibrium [26]. In order to react rapidly to activities, eye tracking is also required for tracking the path of the ball, ensuring that the player is in the correct position to receive the pass, and identifying the location of teammates and opponents [27]. In order to keep up with the other players and the ball, rugby players must be able to monitor the ball with their eyes, which necessitates quick, accurate saccades [28]. Visually detecting important information as rapidly as feasible is critical for making timely motion responses to earlier actions or decisions [29]. Perceptual strategies to extract significant information can be recommended based on the duration and position of the fixation. It is a search strategy that allows for the processing of data from numerous sources and is manifested in gaze behavior [30]. Rugby players can maintain their eyes on the ball at all times while it goes between players and changes location in a matter of seconds because to this visual talent [30].

Eye attention is necessary because the ball and other players move so quickly [36]. Even as general body stamina depletes due to intense exercise, the player must be able to fast shift attention from near-to-far or intermediate targets during the game [37]. Eye concentrating also helps the player shift his concentration away from the coach's instructions and onto his offensive colleagues and the goaltender at the far end of the field [38]. Rugby players must pay attention to their teammates' positions, understand the opponent's actions and tactics, handle the ball, analyze the current situation, and predict what will happen when they play [39]. With distracting stimuli in the visual field, visual concentration allows the athlete to keep concentrate on an object or game [40]. This visual ability allows the player to concentrate on the game, particularly when spectators react or cheer around him/her. Trainings that force the brain and body to work continuously can aid with concentration, focus, and attention span [14]. Maintaining a high level of focus throughout the game allows the player to do well in both the early and late phases, and if the game goes into overtime, this is the most crucial visual talent [20]. Another crucial part of concentration is knowing when and how to shift attention during game play [14]. It doesn't have to be tough to learn to combine focus abilities into a fast-paced sports atmosphere. Activities geared at selective attention, attention focus patterns, and attentional transitions become easier to master with repetition [41]. In a continually changing environment, selective attention is required to decipher the signal's correlation [42]. If all players can learn to stay focused throughout a game while still exploiting an opponent's mistakes on the field, they may find that this is the skill that determines whether a championship is won or lost [37].

Hand-eye coordination refers to the ability of the hand and eye to function as a unit. Athletes’ eyes must guide their bodies to execute the right motor skill at the given time [18]. This skill affects the athlete's timing, reaction speed, body control, and balance. The individual’s visual system guides their motor system because the eyes look straight, and the body follows [20]. Hand-eye coordination indicates how quickly one physically reacts after seeing an object such as the ball and their ability to guide their hands or feet into the right place with their peripheral vision. In rugby, attacking players need good eye-hand coordination to accurately hand off the defender while making a successful pass to a teammate [31]. This will give the rugby player the ability to accomplish the appropriate task during the moment of thought via limbic innervation pathways, which can be crucial in the last minutes of the match, such as a
save or a tackle. Fixation/gazing is used to describe what an individual's eyes are doing and to ensure that they collect more detailed information according to the eyes' normal actions [32]. While playing, the player might be able to react fast and effectively because they fixate their vision or judgment on the moving ball or opponent with more accuracy [33]. Rugby players are required to rapidly process information in a changing, unpredictable environment, which help them improve hand-eye coordination as well as better their visual attention, decision making and action execution [34, 35].

Peripheral vision refers to the ability of an athlete to identify objects in their vision away from fixation. This visual skill can be trained to increase the individual speed of accuracy at which the ball, opponent, or teammate can be identified [16]. Peripheral vision is also associated with the athlete's reaction time as they quickly register objects, opponents, or teammates to their sides and then reacting to them. Sports disciplines requiring multi stimuli involvement, such as rugby, should improve their peripheral awareness (vision) [43]. This skill not only helps a player to better their performance during matches it also helps them avoid injuries [44]. Improving a player's peripheral vision enhances their reaction to seeing the open space and watching the movements of their opponents as they will have a better general vision of the field. When the athlete has bad peripheral vision, they are required to first look around before they can respond, which leads to response time being delayed, this can cause the opposing team to score [45]. When a rugby player wants to perform a grubber kick, they require strong peripheral vision [18]. Peripheral vision can help rugby players to avoid or prepare themselves for a collision, tackle or opponent approaching from the side. This visual skill can be trained and improved as it involves individuals to learn how to broaden their attentional focus, which is a skill [33]. A wing with good peripheral vision will not only focus on the ball passed to him/her, but he/she will also be aware of the opponents surrounding him/her as well as his/her support players at his side and behind him/her [46]. The ability of an individual to rapidly process information from their environment and use it to decide, prepare for the movement, as well as execute the skill [16].

In rugby, the environment consists of running predominantly. Therefore, the change in direction while attacking moves beyond the defense line of the opponent [47]. Thus, rugby players must be able to recognize a pattern or movement and quickly react to prevent the scoring of the opposing team. This visual ability is crucial to quickly scan the environment and absorb all the information to react quickly to the given situation [48, 49]. Players must be able to remember a lot of information, while only quickly scanning the rugby field to decide when, where, and to who to pass the next ball [21]. Dynamic sports require a rapid shift of balance by using the hands, legs, and feet [22]. Skills such as running, tackling, and kicking are essential to playing the game [53]. A faster player has a broader cognition, the faster the player's reaction, and the more likely he/she is to be successful on the field [37]. Within a few seconds, a player can make the correct pass, steal the ball from the ruck without fouling or kick the ball into the right space.

Visual response time refers to the quickness with which the player's brain analyzes and reacts to the opponent's action [62]. A player must respond in a split-second while seeking to recognize chances and dangers on the field [24]. Being able to react faster than an opponent might also increase a player's
chances of defeating the opposing team [23]. To keep up with the competition, the player must be able to interpret visual information faster in order to produce faster plays [50]. The faster a player can react to any set of circumstances, regardless of his or her position on the team, the better the bet [50]. It has shown that players with dark-colored eyes have been demonstrated to react faster than those with light-colored eyes [51]. Thus, in rugby, when a ball is thrown, players with dark eyes respond faster, they perform better under the high balls because their eyes are less sensitive to light and have a higher reaction time. This might be due to the presence of more melenin in the iris in dark-colored eyes [51]. When top rugby league players were compared to non-sporting controls, they had a faster reaction time [52]. We assessed VRT and counted how many saccades and blinks occurred in relation to stimulus onset. We hypothesized that evidence of quicker VRT in athletes could be associated with improved gaze stability [52].

Athletes in numerous sports must absorb and retain a fast-moving, complex image of people and things. This is referred to as visual memory. An athlete with a strong visual memory appears to be at the right place at the right moment [53]. Athletes can study other teams’ modes of play, strengths and weaknesses, through pre-match footage, which produces an expected consequence of the opponents; tactics and allows their moves to be readily intercepted [54] implying that professionals; enhanced memory occurs only when confronted with task-specific experiences. Thus, this study may imply numerous possibilities, such that visual memory is unimportant to rugby skill, that visual memory cannot differentiate level of play in rugby players, and that visual memory has an upper limit in that sport [49]. Skilled players are better than less skilled opponents in remembering and realizing patterns of play, and they have a greater knowledge of what may happen in different scenarios [23].

5. Conclusion

Skill after skill, this study pinpoints the essential visual skills required to perform rugby optimally, as well as their contribution to enhance sporting performance, which leads to a competitive advantage. The listed visual skills highlighted in this study, creates a platform for human performance professionals to include them in their training programs, with an intent to maximize performance, talent identification and to aid in the formulation of visio-spatial test batteries. Even though this list is comprehensive, this is only a starting point for future research to find more visual skills that are essential to rugby, as well as provide the opportunity to develop the performance of the visual skills of these athletes in ways that has not been done before. The findings suggest that interdisciplinary professional relationships with relation to sport vision should be established, so to maximize team and individual performance.

Declarations

Authors’ contribution: Lourens Millard, Gerrit J. Breukelman, Joël Nortje, Teriza Burger and Jessica Schülz all had equal input, in the design of the study, article dissection, content of the study and writing. Lourens Millard advised with the formulation and direction of the article.
**Conflict of Interests:** None declared by authors.

**Funding/Support:** None declared by authors.

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Figures
Figure 1

Data Extraction