

REVIEW ARTICLE



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

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## ABSTRACT

**Background.** Many sports place demands on vision and certain visual skills, and this has long been acknowledged. Among all activities, athletic performance places some of the highest demands on the visual system. Sports vision's fundamental component is the growth and improvement of an athlete's visual ability. **Objectives.** To identify a variety of visual skills essential to netball players. **Methods.** Studies were obtained from the following databases: EBM Reviews, Current Contents, Science Direct, Google Scholar, CISTI Source (1993–June 2021), SportDiscuss (1975–June 2021), Cochrane Database of Systematic Reviews, PubMed (1966–June 2021), and international e-catalogues. A keyword search yielded MeSH headings; “visual skills, “hand-eye coordination”, “peripheral vision”, “eye movements”, “netball vision”, “netball rules”, “reaction time”, “speed of recognition”, “accommodation facility,” “visual memory”, “discriminating efficiency”, “visual endurance”, “motor learning” and “cognitive function” which were combined and exploded. **Results.** This study used 65 full-text English-language papers from 90 citations found through electronic searches. 40 Articles remained after removing duplicates and reviewing the full-text versions. **Conclusion.** The evidence in this study reveals that, although current research still frequently concentrates on visual skills, there is a need to narrow this attention to the requirements of a certain sport. Additionally, identifying the visual abilities necessary for netball, enables talent identification, effective training, and testing of these abilities.

**KEYWORDS:** *Vision in Sport, Visual Skills, Visual Ability, Netball Vision, Talent Identification.*

## INTRODUCTION

One of the most sophisticated and important sensory systems required for receiving information from the environment is vision (1). Good visual and/or perceptual abilities are necessary for good vision, which involves the interpretation of information delivered from the eyes to the brain (1). When it comes to the abilities needed for athletics, vision is the last to fully develop and the first to decline (1). Vision/visual skills are important in the processing of information about a person's surroundings in their daily lives (2). One of a player's most valuable qualities is the ability to communicate effectively through visual means.

The odds are that the visual skills that the athlete uses in their chosen sports are crucial to success in that particular activity (3). One of the most evident differences between decent and exceptional athletes is that elite athletes move their eyes more swiftly and effectively (3). The development and enhancement of an athlete's visual abilities are the foundation of sport vision (1, 4, 5). The kind of sport vision training or visual skills training an athlete receives will depend on the kind of sport in which they compete (4, 5). This visual information is essential for motor tasks demanding precise movements of the limbs concerning a target or

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when players' motions must be coordinated with a changing environment, such as when striking, catching, or kicking a ball (2, 4).

Since the groundbreaking work of Woodworth in 1899, the study of certain movement activities, such as pointing at a target, moving a body segment in space, or reaching for an object, has been closely related to vision and movement control (6). Wilson and Falkel (7) assert that visual perception skills, including visualization, may be taught. Athletes need to be in sync with their visual motor and perceptual systems to compete at their best.

Because netball evolved from basketball, it will need the same ball-handling skills and abide by a lot of the same rules (8). Netball can be described as a fast-paced, quick-witted, and high-scoring sport (4). Furthermore, it requires a player's undivided attention and concentration (4), as the game can be characterized by players' concentration and desperation (4). Athletes might spend hundreds of hours working towards improving their physiological fitness, but if their vision or visual processing abilities are poor, their workouts may not be as effective, and their performance may suffer (9).

Visual training has the potential to develop the visual system (10, 11) so it is critical to understand the impact of visual training on the game of netball. Knowledge of the demands placed on the visual system by netball, as well as the effect of visual training, may influence the management and coaching of these athletes in general (11).

Although various studies have provided information regarding the visual abilities necessary for playing netball, no study has produced a comprehensive list of the visual abilities required for optimal performance (12, 13); as a result, this type of review is vital to comprehend this area of research. To that end, this review article attempts to compile a comprehensive list of essential skills for netball players that will help in the development of a sport-specific Visio-Spatial Skill (VSS) test battery and the identification of potential future players.

## MATERIALS AND METHODS

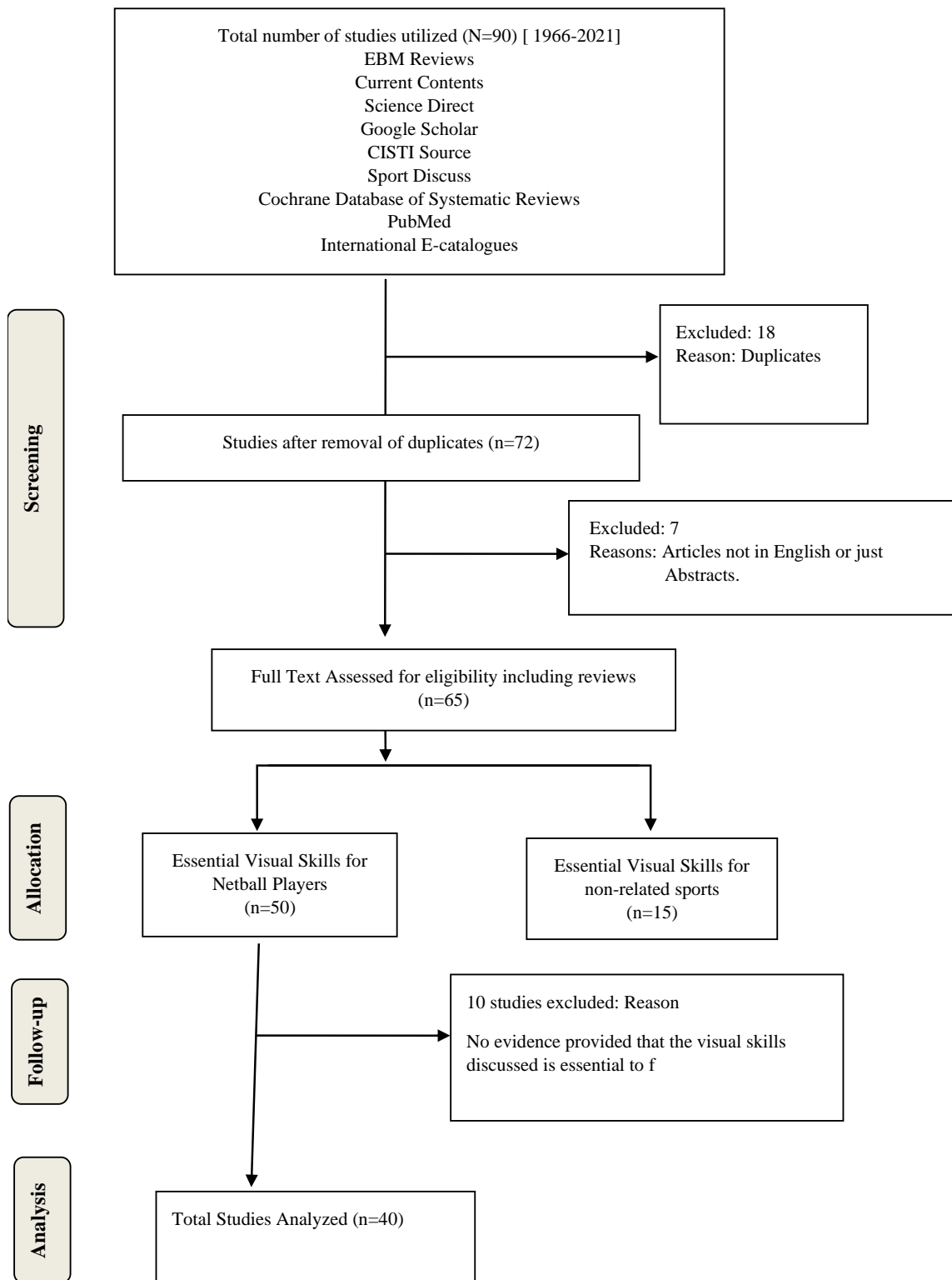
**Search Strategy.** The following databases were searched electronically to assess the literature review on the visual skills required for netball: EBM Reviews, Current Contents, Science Direct, Google Scholar, CISTI Source (1993–June 2021), SportDiscuss (1975–June

2021), Cochrane Database of Systematic Reviews, PubMed (1966–June 2021), and international e-catalogues. A keyword search yielded MeSH headings: “sport vision”, “netball vision”, “vision in sport”, “depth perception”, “eye-coordination”, “accommodation facility”, “fixation skill”, “saccadic eye movements”, “visual skills”, “reaction time”, “peripheral awareness”, “fusion flexibility”, “visual memory”; “concentration”, “visual perception”, “visual skills”, which detonated after fusing. Only peer-reviewed English-language articles were included in the searches. Original articles were categorized and identified for discussion. Please see Figure 1 below to see how articles were selected.

**Inclusion Criteria.** The studies that qualified for this review met the following criteria: A keyword search yielded MeSH headings; “visual skills”, “hand-eye coordination”, “peripheral vision”, “eye movements”, “netball vision”, “netball rules”, “reaction time”, “speed of recognition”, “accommodation facility,” “visual memory”, “discriminating efficiency”, “visual endurance”, “motor learning” and “cognitive function” which were combined and exploded. All the above headings were used to search for articles ranging from 1966-2021 as mentioned below in the data sources section. The reason for the wide search is to find as many visual skills that are essential for netball players as possible, to create a starting point for future studies to identify more of these visual skills to test and train these skills to aid in high performance.

**Exclusion Criteria.** To ensure that only relevant research was included in this review, certain exclusion criteria were implemented. For this study, only full-text articles in the English language were considered. Furthermore, articles were excluded if the studies did not show to be relevant to field hockey. Lastly, articles were excluded if no evidence was provided in the studies to show that the mentioned visual skills are essential to netball.

**Data extraction.** The study that didn't meet the inclusion requirements was removed. After the first author collected and analyzed all the significant data, which also included an analysis of the critical visual abilities in netball. The first author also assessed eligibility for inclusion in a full-text article analysis. The final selection was approved by one of the co-authors, and all faults were fixed until clarity was obtained.



**Figure 1.** PRISMA Flow Chart of the study selection process.

All included papers were categorized under the headings of "vision in netball" or "essential visual skills in netball" depending on the journal

or conference they were published in as well as the corresponding keywords. The information from the data gathering was then extracted. To

examine the contributions of all research into the essential visual skills, we extracted data on analysis methodologies, window selection, and spatial aggregation features. To assess the interpretability of all included research, information on the relationship between match performance, the problem definition or study purpose, and the inclusion of a theoretical explanation of strategic behavior was also extracted. All of the findings were then organized into categories and placed under a single framework, which will act as the framework for our discussion of the findings.

## RESULTS

This study used 65 full-text English-language papers from 90 citations found through electronic searches. 40 Articles remained after removing duplicates and reviewing the full-text versions.

We found several visual skills that are required in netball, some of which are more important for performance than others, but all of them are relevant and help netball players perform better; see [Table 1](#) below for a list of all the essential visual hardware skills, and [Table 2](#) for a list of all the essential visual software skills, both with descriptions of each visual skill.

**Table 1: Essential Visual Hardware Skills for Netball Players**

Visual Skills:	Description	References:
Dynamic Visual Acuity	The ability to accurately fixate one's vision or judgment on a moving object during play may enable players to react more swiftly and efficiently	[23-26]
Accommodation facility	An athlete with accommodating skills may quickly switch their focus while playing the game and maintain it while doing so	[27-30]
Fusion Flexibility	This visual ability aids in keeping two objects	[31, 32]
Fixation	This visual ability aids in keeping two objects together as one	[7, 27, 31, 33]
Visual perception	Athletes must be able to estimate the distances between themselves and other competitors	[5, 27, 31]

## DISCUSSION

Previous research indicates that specific visual skill sets are sport-specific since each discipline has different visual demands and needs (14). Optimal sports performance cannot be implied by well-developed cognitive processing of the incoming visual information in the absence of high-quality visual information (15). An individual's response to information will be flawed if there is any inaccurate information input because of the visual system, which could subsequently result in motor deficiencies (16). Additionally, a recent analysis supports the idea that, like motor skills, visual skills have an impact on athletic performance (17).

Athletes must quickly gather a large amount of information, primarily visual, from their surroundings to perform appropriate motor tasks (18). During a game of netball, the ball and the player's positions provide visual information (5). It has been suggested that visual skills training exercises help athletes improve their visual abilities and, as a result, their performance abilities (7).

Few, if any, previous research has examined outcomes, movement, and cognitive aspects in addition to looking at the effect of vision on performance. A visual skill, according to Bressan (19), is the ability to accurately read the optic array. Consequently, there is a cognitive component to visual skills. In other words, the capacity to understand visual information will be influenced by things like prior experience (5, 7). While a visual skill entails the perception of visual data, a visual ability comprises the reception of visual data. It's crucial to remember that visual aptitudes assist visual aptitudes. Additionally, visual skills need to be categorized to understand the effect that continuous performance and training have on these skills before testing or training can begin (1, 5, 7). Visual skills can be categorized according to Visual Software and Visual Hardware skills (20).

'Software' visual skills provide athletes with an advantage in recognizing visual information, recalling visual facts, and making decisions, which leads to improved sports performance (20-

22). Visual hardware is the mechanical and optometric characteristics that make up the visual system's physical characteristics (20). A lack of 'hardware' visual skills, such as below-normal visual acuity (clearness of vision), may impair cognitive performance (6, 14). The visual skills identified in this review are thus as follows:

Visual Hardware: Visual acuity, Accommodation, Fusion flexibility, Fixation, and Depth perception. Visual Software: Saccadic eye movements, Concentration, Eye-hand coordination, Peripheral vision, Speed & Span of recognition, Visual reaction time, and Visual memory.

**Table 2: Essential Visual Software Skills for Netball Players**

Visual Skills:	Description	References:
Saccadic eye movements	Eye movements are crucial for gathering precise visual data from pertinent scene locations	[34, 36]
Concentration	Netball players must have the ability to focus and always concentrate to perform at their best	[30, 31, 37, 38]
Eye-hand coordination	If players have good eye-hand coordination, they will be able to hit that sweet spot every time	[8, 31, 40, 41]
Peripheral awareness	Netball players need to have this visual ability because it allows them to be more aware of their surroundings.	[27, 41, 42]
Speed of recognition	A visual skill called speed and span of recognition enables players to adapt and react to a play as rapidly as possible.	[27, 31, 35, 39]
Reaction time	The bigger the player's lead is before the opponent reacts, the faster they play	[2, 27, 31, 39, 43]
Visual memory	For the player to process events occurring during or after the game, visual memory is also crucial	[9, 35, 39, 44]

**Visual Hardware.** One of the most crucial abilities required for the best possible netball performance is dynamic visual acuity. Vision needs to be sharp while moving, as well as while the ball or other players are moving. Netball is a constantly moving activity, thus having dynamic visual acuity is crucial for optimal performance (23, 24). Athletes need to be able to perceive fast-moving objects clearly in addition to having excellent eyesight (25). This ability will enable the players to focus on the spatial location of the ball and the field as well as the simultaneous movement and positioning of teammates and opponents (24). Netball players with excellent tracking skills can forecast and assess athletic performance (26). Players who possess this visual ability can keep vision clarity while moving, whether it is with the ball, other players, or both. Being successful in netball requires dynamic visual acuity due to the game's constant mobility (25). The player will perceive images that are crisper and collect more information from other players, the ball, and the background as their visual acuity increases.

An athlete with optimal accommodating skills may quickly switch their focus while playing the game and maintain it while doing so (27, 28).

Netball players need to be able to quickly shift their attention as the ball is tossed their way or to them (27). For athletes to be able to focus quickly on a stable and clear vision, especially when trying to fixate from far to near or vice versa, accommodations are essential (29). Any sport that demands athletes to move their visual attention to objectives at various distances from them must have the ability to accommodate and use vergence. The ability to accommodate enables athletes to keep their eyes fixed on an object while it changes from one distance (near) to another (far) (28, 29). Because the ball is continually traveling from player to player, from the player to the net, through the boundary lines, etc., this visual ability is crucial for netball (27). Accommodation thus enables athletes to quickly change their attention to follow the ball while retaining vision clarity (30).

Knowing whether an athlete's two eyes are operating together is crucial, which is known as fusion. This visual ability aids in keeping two objects together as one (31, 32). Additionally, it shields players from double vision and poor direction-following while playing (31). A player



will be able to keep up with other players and recognize the ball as it moves in space. If there is a fusion deficit, a netball player may have double vision, misjudge direction, and struggle to keep up with the ball and other players on the field of play. The entire athlete's performance is affected as a result (31, 32). Although there are two eyes, binocular vision normally only has one item of interest, which is one of the difficulties (31). When seeing an image from various angles, this visual skill also aids in maintaining its originality (31, 32). A netball player may experience double vision, poor directionality, and difficulty keeping up with the ball and other players on the field of play if there is a fusion deficit (30). As a result, the entire athlete's performance is impacted, hence this is a crucial visual skill of netball players.

The fixation/gaze is a phrase used to explain that eyes gather more detailed information following the eyes' typical motions (33). Fixation is essential for shooting accurately at the intended target. A netball player must swiftly fixate on his or her goals, such as the back of the rim or a bank point on the backboard, before releasing the shot and continuing to keep fixating on the area (27). The ability to accurately fixate one's vision or judgment on a moving object during play may enable players to react more swiftly and efficiently (7). In addition, it can make the athlete's match preparation simpler, enabling him or her to apply the newly acquired ideas to their sport after learning them (7, 31). It also makes it simpler for netball players to maintain their attention on the task at hand and to block out any distractions from supporters or bystanders by blocking out extraneous information or colors (27, 33). A player will be able to shift their focus from the ball to the other players with this ability despite their eyes moving constantly.

Athletes must be able to estimate the distances between themselves and other competitors (31). Netball is a sport that moves quickly and constantly. To judge the distance swiftly and accurately between players, their teammates, their opponents, the ball, boundary lines, the net, etc., depth perception is necessary (5, 27). This visual capacity enhances players' ability to pass to players on the opposite side of the court, judge the defensive positions of the opposing team's players, and limit shots that are not high enough or bounce off the rim (5, 27). There is no alternative for a player's ability to assess the

rotation of the ball and the speed at which the opposition team is moving toward or away from him (31). Additionally, because of how packed the court can be for netball, athletes must understand their position concerning other things (27, 31). Due to their depth perception, players can assess distances quickly and accurately from themselves to opponents, the ball, teammates, and boundary lines.

**Visual Software.** Eye movements are crucial for gathering precise visual data from pertinent scene locations and enabling the best possible management of human motion in a game (34, 35). Athletes' gaze patterns reflect the perception-based judgments and motor actions carried out in fast-paced sporting environments (34, 36). This visual ability recognizes and clarifies abnormalities between eye fixation and object position. Referee's performance and decision-making in sporting events depend heavily on quick saccadic movements (34, 35). A previous study found that netball players who performed saccadic eye motions during pre-season had lower immediate memory, but immediate memory improved after extensive eye training sessions (36). As the athlete swiftly scans from one object to another, it can be necessary for them to make a smooth tracking movement or a fast jump.

Netball players must have the ability to focus and always concentrate to perform at their best (37). Players that are easily distracted can miss a teammate's pass or an easy layup, which would be disappointing and frustrating (37, 38). High levels of concentration will aid players in maintaining their attention on the ball, their teammates, and their opponents, allowing them to move around the court and score points to win the game (38). The ability to perform well in both early and late game phases depends on maintaining a high degree of concentration throughout the game (31). Another big aspect of concentration during gameplay is knowing when and how to switch your focus as an athlete (39). When viewers are responding or applauding around the player, this visual ability helps the athlete concentrate on the game. The ball will simply go into the goal and the team will score when players are focused and have superb technique (37, 39). A player will perform at their best when they have this visual capacity because they won't be easily distracted (30).

Eye-hand coordination must be well developed to be successful in a fast-past activity like netball since it is closely linked to the visual

information that the brain processes. If players have good eye-hand coordination, they will be able to hit that sweet spot every time (8). A team's capacity to move the ball around the court effectively and strategically is a requirement for winning netball matches (8). An individual's standing throw shoot is also influenced by their eye-hand coordination. The accuracy of a netball player's throw will depend on their capacity for hand-eye synchronization when attempting free throws (31, 40). When playing handball, the eye-hand coordination is important, especially when the shooter can see the goal and release the ball further in that direction (40). Poor eye-hand coordination, on the other hand, will result in a rigid shooting movement, causing the ball to deviate from the goal. According to Wagner et al. (41), players must develop the high-level movement coordination to run, jump, push, change direction, catch, shoot, and block.

Athletes can see everything around them using peripheral vision without turning their heads (42). An offensive player uses his peripheral vision to discover an open teammate to pass to, spot a defensive player trying to steal the ball and keep control of the ball as he is dribbling (41). While concentrating on the player he is defending, a defensive player makes use of his peripheral vision (41). He can locate the ball on the court, see the scoreboard with the time on it, and determine his distance from the basket thanks to his peripheral vision (40). Netball players need to have this visual ability because it allows them to be more aware of their surroundings, the other players around them, and anything else going on the floor (27, 41). Peripheral vision is used for encoding a dynamically changing visual environment (42). Players can use this visual skill to process information from multiple locations (41). Athletes that possess this skill can keep an eye on objects while also detecting change events, including motion changes, even at great eccentricity (27, 41). Peripheral vision will likely be employed extensively, and attention will be dispersed proportional to various areas in tasks like those that require watching a ball and several players to process important information.

Speed and span of recognition enable players to adapt and react to a play as rapidly as possible (31). A speedier athlete might, for instance, be able to reach a ball faster than an opponent or even outrun a pursuer. Therefore, athletes in most sports place a high value on speed (35). A player

must identify the potential for a certain play development as soon as possible. Players have just milliseconds to release a shot, make precise pass-through traffic, stop a shot, or identify a certain offensive or defensive setup (39). This visual ability is crucial in netball since a player's window of opportunity to take a shot, make a precise pass, or stop a shot is extremely constrained. Netball players will do effectively on the court if they have good speed and recognition abilities (35). A player's chances of succeeding in their netball performance increase with his recognition quickness (27). The player needs to be able to digest a lot of information with just a quick sweep of the court to make play-related decisions like whether to pass the ball, where to position oneself next and other things.

Netball players need to be able to respond as soon as possible to any circumstance that arises because the game moves so swiftly (31, 43). It will be beneficial in situations like interceptions and rebounds if their reactions are automatic (27). To respond to an event that is taking place in front of them, players need around 0.2 seconds. By the time the defense has had a chance to respond, the offense has the upper hand since they anticipate what will happen next (2, 31). The speed player can move the ball, alter direction, fake a shot blocker, and take the initial step toward slipping past the defense. The bigger the player's lead is before the opponent reacts, the faster they play (31, 39). The efficiency with which the visual system processes information determines the player's ability to act quickly and accurately (39, 43). A player's likelihood of defeating the opposing team can also be increased by responding quicker than an opponent (2, 43). The players will be able to move the ball quickly, avoid colliding with other players, and quickly adjust to the ball's changing path thanks to this ability.

For an athlete to process events occurring during or after the game, visual memory is also crucial (9). Since netball moves quickly up the field, it is essential. To recall where their teammates and opponents are, athletes can employ visual memory (9, 35). A player with visual memory appears to be in the right place at the right time all the time (44). Athletes with strong visual memories will be able to visualize and practice scenarios, moves, and reactions that can and do happen during the game (35, 44). To make them more effective and correct, the athlete can also mentally change them. Then, they will be able to

apply this knowledge to similar circumstances in the future (35, 39). Competent players memorize and recognize play patterns better than less skilled opponents, and they are more aware of potential outcomes in certain situations (39). With the help of the visuals they record, players will be able to decide quickly and precisely what to do next in a game by using this talent.

To determine whether, when, and how sportsmen and sportswomen might be helped to improve their visual skill performance through vision-based intervention programs, it is vital to understand how the visual system functions during sports performance (45). In the past, analog "eye fitness" exercises were used as early approaches to Sport Visual Training (46). These exercises placed high demands on the oculomotor system and required trainees to quickly change their visual convergence, accommodation, saccadic, and/or pursuit eye movements to visual targets (46). For instance, research on club-level cricket batters revealed that a visual training regimen performed for 30 minutes, three times per week for six weeks improved basic visual functions like depth perception, accommodation, and saccadic eye movements as well as batting statistics compared to placebo and control groups (46). It was discovered that, compared to controls, those who received vision training had faster and more accurate netball passing using an identical set of analog vision training tasks over five weeks (47). The new NeuroTrainer device (NeuroTrainer VR | Develop Mental Control and Cognitive Advantages, n.d.) likewise makes advantage of multiple object tracking. A sequence of dual tasks that alternately challenge athletes' attention and peripheral vision is used in this training regimen (48). Virtual reality (VR) platforms and computational simulations have been increasingly popular over the past few years as alternative ways to replicate game action. These simulation systems enable the creation of intricate training regimens that can closely resemble in-game actions, giving athletes the chance to practice in their minds what it would be like to run genuine plays in the first person (48). Thus, by identifying the visual skills that are essential to netball, one can specify which visual training regime can be used to lead to higher performance of the players.

## CONCLUSION

The strength of this study is that it provides an in-depth analysis of the visual skills required for

netball. The study's limitation is that there is a limited amount of previous studies with information on visual skills required for netball, as well as information about the importance of these visual skills specifically for netball. Furthermore, even though this was an in-depth analysis with regards to the essential visual skills required for netball, there is always the chance that there were visual skills missed which is why this study only acts as a starting point for future studies to add visual skills which are essential to netball.

This study emphasizes the necessity to narrow this attention to the requirements of a specific sport even if current research still frequently concentrates on single visual abilities. This analysis offers a comprehensive overview of not just the visual skills necessary for netball, but also the reasons why they contribute to peak performance. The eleven crucial visual skills for netball established in this study serve as a foundation for the acquisition of new visual abilities. Additionally, by defining these skills, future studies will be able to develop netball-specific visual skill test batteries, giving researchers the chance to objectively demonstrate whether these visual skills can be learned and result in the best performance. Coaches will be able to recognize talented players earlier by having the chance to test and train these visual abilities, which in turn will raise the possibility of competitive advantages.

## APPLICABLE REMARKS

- This analysis offers a comprehensive overview of not just the visual skills necessary for netball, but also the reasons why they contribute to peak performance.
- The eleven crucial visual skills for netball established in this study serve as a foundation for the acquisition of new visual abilities to be added in future studies.
- Additionally, it provides the basis for sport-specific Visio-spatial test batteries that can be created to aid in the high performance of netball players.

## AUTHORS' CONTRIBUTIONS

Study concept and design: Nonkululeko Mathe, Lourens Millard, Gerrit Breukelman, and Musa Mathunjwa. Acquisition of research articles: Lourens Millard and Gerrit Breukelman. Analysis of research articles and information: Lourens Millard, Nonkululeko Mathe, and Musa Mathunjwa. Drafting



of the manuscript: Nonkululeko Mathe, Lourens Millard, and Gerrit Breukelman. Critical revision of the manuscript for important intellectual content: Lourens Millard and Gerrit Breukelman. Statistical analysis: None as this is a review article. Administrative, technical, and material support: Gerrit Breukelman and Nonkululeko Mathe. Study

supervision: Lourens Millard, Gerrit Breukelman and Musa Mathunjwa.

### CONFLICT OF INTEREST

There is no conflict of interest declared by the authors.

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