Vision training and its effect on the performance of athletes: The case of football players

Xara Maroutsou

SAERA. School of Advanced Education Research and Accreditation

ABSTRACT

The application of the method of Vision Training (VT) in the field of sports and specifically in football was studied, surveying modern bibliography. Amazing vision is required by the professional athletes to perform well in their sports, and numerous of them have turned to vision preparing programs as a way to enrich their conventional preparing regimen. The developing hone of 'sports vision training' depends on the idea that hone with requesting visual perceptual, cognitive, or oculomotor errands can move forward the capacity to prepare and react to what is seen, subsequently progressing wear execution. This undertaking is not essentially modern, but has been advanced incredibly within the past few years by unused computerized innovation that can be applied to characteristic preparing exercises, by perceptual-learning-inspired preparing programs, and by virtual reality recreations that can reproduce and increase wearing settings to advance certain sports-specific visual and cognitive capacities. These made strides capacities may, in turn, instill a competitive advantage on the playing field, underscoring the potential esteem of these approaches. This article surveys developing approaches, innovations and patterns in sports vision preparing.

Keywords: *Vision Training, football players, athlete's gaze, practice, behavior, visual skills.*

INTRODUCTION

Vision Training is a sequence of procedures/exercises of vision by using special instruments or electronic programs (equipment/balls as visual targets), in which the brain and the eyes cooperate and it is adapted to the age, the dysfunction of the vision and the personal needs (Onate et al., 2019). As we will see below, through Vision Training additional physical demands should be placed on the athlete to simulate the demands of their specific sport, as in this case in football.

When discussing vision training with soccer players, we use a three-step approach to describe it. Sight-Players must observe and orient themselves to the visual scene as quickly as possible. For example, a safety must be able to understand the direction of an approaching receiver, track multiple receivers in his path, understand the space between the receiver and the cornerback, and determine the quarterback's intended action. The quarter back does the same by judging the space between the defender and receiver and anticipating the play's action.

Regarding judgement, the player must then make decisions based on the visual information he has taken in. For example, a running back must quickly identify holes in the line and potential blockers and decide which direction to run. In terms of the action, the player takes action based on visual information and quick decisions takes in changes in the visual scene, and begins the process again.

In this effort our goal is to highlight all positive parameters of Vision Training's application in the field of football, in relation to football players and their skills in the football field. Furthermore, our research is related to how much the skills of the athletes can evolve and its impact on dealing with sports rivals. Through searching specific scientific bibliography it is considered appropriate to strengthen the bibliographic research on Vision Training in Greece.

RESULTS

This thesis is a bibliographic research in which we studied certain theories and views about vision training in the field of football. More specifically we studied how VT leads the bodies of the athletes´ to how and when to react to the informations they receive. The vision of the athlete is inextricably linked with the athlete´s performance, as it has to do with the athlete´s kinesiology and his perception on the field, so that his performance on the field may suffer if his visual system does not receive the message correctly or quickly. The reason I dealt with this particular topic is that there is not much bibliographic research on it in Greece; as well as my professional involvement in the specific field.

The basic articles and books chosen are the following: fewer fixations of longer duration? Expert gaze behavior revisited (Klostermann and Moeinirad, 2019), A review of the essential visual skills required for soccer: Beyond 20–20 optometry (Millard et al., 2022), Visual Perception and Action in Sport (Williams et al., 2020), Soccer Science and Performance Coaching Develop an Elite Coaching Methodology With Applied Coaching Science (Owen, 2023). The effect of stroboscopic vision on performance in a football specific assessment (Beavan et al., 2020), Optimizing Visual Performance for Sport (Erickson,

2018), Stroboscopic Visual Training: a Pilot Study with Three Elite Youth Football Goalkeepers (Wilkins and Tweddle, 2018).

VT for athletes and more specifically for football athletes´ is the application of specific exercises conducted over a period of time that leads to neural restructuring of the cortex and brainstem pathways, allowing an individual to maximize efficiency while performing tasks that lead to improved motor skills performance. A total of 80% of the information we receive from the environment and respond to is visual stimuli. In other words, vision controls the body and movement. In ball dominance the visual system must work properly.

VT can strengthen and sharpen the athlete´s perception and help him manage his senses and, by extension, his body on the sports field during the match. They can improve their performance on the field and develop an advantage over their opponents (Onate et al., 2019) as football is a sport that requires quick decision making, quick reflex movements, accurate and effective perception of space. Also, enable the athlete to have empathy and external contact and perception of space and the situation in the space he moves and interacts with his opponents, to wit to create an improved reaction space. Another advantage is that visual acuity can be enhanced to see clearly and distinguish details on the playing field for more accurate passes.

Finaly, through this thesis is particularly important to emphasize that Vision Training should focus more on the needs of each specific sport, as in our case of football, and focus more on the needs and pathologies of football players in order for them to be able to strengthen the current needs of the visual and nervous system of their brain.

The question remains as to how it could be Vision training prevents injuries. Through the above researches and studies that we cited in this work, it is understood that VT and stroboscopic training (SVT) expanding the field of athlete awareness or functional peripheral vision. It is very important to emphasize in the present study that using VT methods, the eyes and brain of football athletes can use the information obtained within field of reactive functional peripheral vision fast to their changing environment, avoid collisions that can cause injury.

METHOD

This thesis is a bibliographic research on Vision Training, which is most commonly applied to the training and improvement of vision skills (Graham, 2020). More specifically this research focuses on the use of Vision Training in the field of sports, especially football through the study of and commenting on articles related to the subject.

Bibliographic review articles are the methodology of observational research, systematic, selection, analysis, interpretation and discussion of theoretical positions, results and conclusions embodied in scientific papers to obtain relevant information has been disclosed in recent years on the topic of choice it contributes to the solution of the problem.

This particular research is a systematic review according to PRISMA. The databases searched are Google Scholar, Springer Link, Taylor and Francis Online, Pub Med (Biomedical). The keywords introduced are «Vision Training in Football», «Vision Therapy», «optomotor cooperation», «essential visual skills for football players».

Fifteen articles were found on the subject as well as the books Visual Perception and Action in Sport (Williams et al., 2020) and Soccer Science and Performance Coaching Develop an Elite Coaching Methodology With Applied Coaching Science (Owen, 2023). Six articles were finally chosen as basic articles of this review on the basis of the scientific competence of their editors, of their recent publication, and of the fact that these articles presented the results of the vision trainings's application on football players. The rest of the articles found were not chosen as they did not meet the above criteria, that is, they were related to older researches or to vision training and sports in general and not to vision training and football in particular.

Vision Therapy and optomotor cooperation (eye-hand) of athletes

Vision Training is also known as Vision Therapy. It consists of a variety of programs to enhance visual performance (Naomi, 2017 ; Basic and Rutner, 2023). The basic principle of Vision Training as applied today, is that vision can be taught. Each application of Vision Training is personalized according to the needs of each person, so that new skills can be learned or reinforce the already existing ones. The exercises aim to give the person a chance to have the appropriate experiences to learn to view more correctly and efficiently.

The method is progressive, which means that in the beginning the exercises are easier and gradually become more and more difficult, so that the flexibility and the coordination of the eye muscles is being improved (De Angelis, 2011). The trainees learn how to control the muscles of their eyes and get able to overcome many oculomotor problems (Page and Stritzke, 2014). The method includes the improvement of vision skills, such as binocular cooperation, depth perception, detection ability and optomotor cooperation (eye-hand) (Keiner and Roelofs, 1955). This gives a person the opportunity to learn more effective ways to perform visual activities. In this case, in the field of sports, vision training can strengthen the prospects for success of athletes. It can also help to find athletes who need specific visual help (correction or improvement). (Hernandez Mendo et al., 2019).

Vision Training can contribute the extensive and analytical examination of vision, so that the extent of the problem can be evaluated. Vision Training can help the athletes who suffer functional vision problems (Song and Weidong, 2010). VT can improve the skills required for each sport (perception of space, distance, hand-eye-body cooperation, depth of field) through specialized training of vision and the reaction of a person given specific visual abilities. It can also improve the visual ability of players with special abilities (Velissarakos et al., 2013).

In competitive sports and especially in championship, more specifically in football, athletes reach high levels of performance and competition looking for continuous improvement of even small details of their daily training effort, in order to gain an advantage against their opponents (Farrow and Raab, 2013). VT reinforces this perspective.

Sports vision has scientifically and clinically been recognized as specialized field of the athletic medicine during the last twenty years (Erickson, 2020). VT uses expertise and human resources in ophthalmology and optometry science to not only diagnose and correct refractive errors in athletes (myopia,

astigmatism, hyperopia, etc.) achieved by conventional eye examinations or general laser surgery, but also to prevent and cure eye injuries (Erickson, 2020).

This specialized science improves the coordination of the visuomotor reactions (through practice using appropriate scientific equipment) and also informs the athletes, coaches and conjugators about the "visual" demands of the sports in which they participate. All the above aim to improve the athletes' performance in the competition (Erickson, 2020). Sports vision aims to diagnose, correct and perfect the vision, scout talents, prevent and cure injuries (Erickson, 2020; Chappelet, 2010). In football, the accuracy and the speed of the eye movements (saccade movements which is responsible for motion processing) are important (Press, 1997).

The exercises find the weaknesses and help the athletes to better control their bodies, their eyes, having a better sense of the part of the body they use. VT trains the visual system to work loosely at will, so that exists more available reaction time and immediate perception of small details of body posture of the opponent. The exercises also eliminate asymmetries in the perception of space so that the athlete perceives precisely his position and the position of his opponent (Vickers, 2007).

In VT it is very important the control of their bodies under intense game conditions. Visual spatial recognition training, where athlete see shifting targets through prisms and lenses, is designed to help athletes maintain balance and control (Deardorff, 2000). VT can help athletes who perform less when stressed on under pressure, that is perform well on when not much is at stake in the game. Their performance is not stable. They know what to do but they don't do it. They train a lot with no result. They overthink when they play (Perry, 2020).

The behaviour of the athlete's gaze

Visual perception in sport has attracted widespread interest from researchers and practitioners. Also practitioners manipulate and measure biological, psychological, and sociological factors when studying and proposing VT (Edson and Tenenbaum, 2020; McGuckian et al., 2020). Some studies and bibliographical researches have documented interobserver reliability of visual in sports (Knudson, 2013).

Fundamental premise for the visual perception is the behaviour of the athlete' s gaze, which is considered that «improves the visual information processing which allows the optimal coupling between perception and action» (Aksum et al., 2020) (to maintain this 'oneness' on athlete's eyes in all areas of gaze). All these actions and responses that can and do occur during sporting activities, modify them to be more efficient and correct for the athletes (Williams et al., 2020). With VT athlete's gaze and motor behaviour is determined within an experimental environment that is similar to that found in the sport area (Vickers, 2011).

Although previous researches had proposed that no information intake takes place during saccades, more recent research proposes that the vision is clear and stable during the saccadic movements of the eyes (Aksum et al., 2020). About saccadic movements in sports according to Williams et al. (2020):

''In sport, a performer may use saccadic eye movements to scan quickly from one player to another or from a ball to a target such as a golf hole or a basketball hoop. Therefore,

saccades are rapid movements of the eyes to a new fixation point, enabling another informative area of the display to be fixated'' (Williams et al., 2020:147).

An extensive number of researches that refer to the behaviour of gaze at football had been focused on the number, the duration and location ''of fixations in different video-simulated football scenarios conducted in laboratory settings'' (Aksum et al., 2020). Much of this research has attempted to investigate differences in gaze behavior between football players at different levels and experience. For example the differences in gaze behavior depend on whether or not penalty takers perform a run-up irrespective of the presence of a real goalkeeper (Kurz, and Munzert, 2020).

According to the study of Klostermann and Moeinirad (2019) which is mentioned in gaze behavior in sport, "empirical evidence on expertise-related differences in gaze behavior has declined in recent years with heterogeneous findings related to fixation duration and the number of fixations" (see Aksum et al., 2020). This is related to less dynamic sports or tasks. A typical example is football (Aksum et al., 2020). VT have also investigated quiet eye in the context of anxiety. The results of these learning studies showing a positive influence of learning on quiet eye duration (Aksum et al., 2020). According to Klostermann and Moeinirad (2019):

For gaze location and quiet eye duration, different gaze behavior in experts was found, in particular, when compared to novices. However, for fixation duration and number of fixations the results were less clear (Klostermann and Moeinirad, 2019).

According to Klostermann and Moeinirad (2019) all experimental activities related to Vision Training and to gaze behaviour in sports affect directly the behaviour of the athletes' gaze and more specifically of football players. The representativeness of experimental labours has also been proved to affect the behaviour of the gaze of athletes at different levels (Klostermann and Moeinirad, 2019).

A typical example of what was said above is that in the field of football VT exercises are differentiated according to the positions of the football players in the field. According to related study: "studies of simulated 11 v 11 play have shown that the number of fixations increases, the duration of fixations decreases, and the location of fixations is directed toward more objects of information when the ball is far from the player" (Aksum et al., 2020).

As the ball approaches, the position of the gaze becomes more focused towards the player in possession. Similarly, when players are constrained by time, they tend to focus their gaze while using their surrounding field of view to extract information from other players' positions and movements. This type of gaze behavior is called "fovea". The main advantage of this type of gaze strategy is that the information is processed more peripheral faster, and it is advantageous to rely on peripheral vision in time-constrained situations (Aksum et al., 2020).

The representativeness of experimental tasks has also been shown to influence the gaze behavior of athletes at different levels, with increased representativeness mediating expertise effects in gaze positions. For example, certain studies showed how players spent more time observing open spaces and had a shorter period of fixation from an aerial

perspective than from a playing perspective influenced the gaze strategy of football players. It is unknown to what extent it is possible to shift the knowledge of gaze behavior in experimentally controlled situations to gaze behavior in actual sports competitions. The reason for the limited representativeness is that the experimental tasks performed in a laboratory setting are difficult to fully explain the dynamic performance context experienced by athletes (Aksum et al., 2020).

In football, action differs from a complex array of visual, auditory, kinesthetic, bodily sensations, defensive pressure from opponents and constraints on certain tasks, such as position on the field, and in addition, field-based studies, gaze behavior may help to develop knowledge about the binding of perception and behavior movement from the flow of movement and behavior to simply therefore specific performance. There was a call for researchers to study gaze behavior in environments that represent performance contexts (Aksum et al., 2020).

According to research of Aksum et al. (2020) We may need to get enough information before the player carries out his decision in more complex situations (i.e., located between the opponent's line of defense) (Aksum et al., 2020). According to their research Aksum et al. suggests that: these discrepancies from researches about VT, raise the question of whether it is in sufficient to examine the visual fixation of a footballer in a laboratory setting when trying to capture the fixation of a footballer's gaze during match play dynamics where different landscapes of information and sensation affect both decision-making and gaze behavior (Aksum et al., 2020). In short, coaches need to be aware of how visual fixation and search strategies vary depending on the numerical, spatial and temporal conditions of the movement (Aksum et al., 2020).

The essential visual skills required for football players.

In ball sports such as football, the visual system is important in guiding the player's search for important information that underpins skillful behavior that requires all the incorporation of relevant information in the environment to make successful decisions under pressure. However, focusing on the vision of a sport, and the specific visual skills required to be successful in a particular sport, has been an exercise largely ignored by professional football coaches as being an essential component of athletic performance. It' s important to summarize and compile the visual skills required for football and the immediate connection with VT. Current research tends to focus on overall visual skills. This focus needs to be streamlined on specific sports essentials. In addition, effective training and testing of these skills, as well as the identification of talents, will be possible when identifying the visual skills essential to football (Millard et al., 2022).

Vision is a signal that guides the body to react and provides the athlete with information about when and where to act. If the vision system does not receive the message correctly or quickly, it can cause a decrease in motor skills. Motor skills are one of the most demanding activities for the visual system, so it is important for the visual system to function at a high level. Vision is more than seeing clearly, and it is interconnected visual skills that affect performance. It can also improve the

athlete's visual fitness and visual accuracy so that the exercise and drill can improve the speed and strength. In sports, vision may affect an athlete's performance, including visual clarity, athletic performance (ability to perform specific tasks) and information processing. The general ability to process and respond to visual stimuli also greatly improves the visual ability of athletes (Millard et al., 2022).

It is very important to mention the research of Millard et al. (2022). In this research they report how interconnected is the relationship between science and sports The fact is that this review still tends to focus on visual skills in current research, but needs to streamline this focus on certain sports essentials. This review provides a detailed list of the essential visual skills in football as well as the reasons why it leads to optimal performance. Sixteen essential visual skills for football identified in this review provide a starting point for adding additional visual skills. In addition, identifying these skills will allow future research to create visual skills test batteries specific to football, creating opportunities to empirically prove whether these visual skills can be trained and lead to optimal performance. By providing an opportunity to test and train these visual skills, coaches can identify talented players early, thereby increasing the potential for competitive advantage (Millard et al., 2022).

Football has attracted the attention of world spectators and is currently the most popular sport in the world. To control the ball on the ground, you must have precise motor and visual skills to keep the opponent's player away from the ball and advance it from one end of the next pitch. It requires a variety of explosive activities, such as maintaining a strong contraction. Visual skills are essential to ensure that football players are able to perform the necessary skills effectively (Millard et al., 2022). Because of the interaction between visual skills and perceptual cognitive skills to take place in a football game, the player must have a very large capacity to support the request. In this sense, the ability to properly manage cognitive abilities and perception is extremely important (Owen, 2023).

Over the years, the role of visual performance factors in football has attracted considerable attention, but many athletes still have no access to evaluation and improvement methods. While there are other studies that provide information on visual skills essential to football, there are no studies that have produced a comprehensive list of visual skills essential to optimal performance. Therefore, this type of review is necessary to understand this field of study. This review article aims to create a comprehensive list of essential visual skills for football players to help them develop a sports-specific Visual Skills (VSS) test battery and identify future talents (Millard et al., 2022). Interestingly, such factors (attentional processes) have attracted increasing scrutiny from cognitive scientists in recent years (Moran, 2012). Players often take on improving their peripheral vision to better read the game, which can be done through certain vision training exercises or simply by paying attention to the movements of other players on the field (Erickson, 2020; Cole, 2023).

Visual memory is the ability of the eyes and brain to identify field or court patterns and process that information quickly and effectively. This is a skill that can be taught and strengthened, which has become a useful tool for athletes. Visual memory is important

for players to process and remember actions taken during or after the game (Millard et al., 2022). In this game, football players form a huddle, in which they receive a coded sequence which specifies the process (Parkin, 2016). Football is an action that is stored in procedural memory. At this point, it is important to note that many of these actions are acquired first by deliberate practice (which is a form of explicit knowledge acquisition), before the action (Weigelt et al., 2023).

Visual adjustment ability refers to the ability of the eye to integrate with the body, is the body's ability to adjust the movement in response to stimuli. During a football game, the environment changes and the visual system needs to be adaptable enough to quickly and accurately change the motor response. Poor visual coordination can slow the response and lead to inconsistent execution of skills (Millard et al., 2022). It is very important for visual cues, body movement and space positioning. It integrates neck, eye and body adjustment into motion and helps the head in relation to gravity and motion (Fouse and Wheeler, 1997).

Stroboscopic Visual Training (SVT) Method in football players

In this section we will study the stroboscopic training (Erickson, 2020). Stroboscopic Visual Training (SVT) is a placement practice about individuals under intermittent vision conditions, often using specialized eyewear in an attempt to increase visual acuity and perceptual skills. From a sports perspective, this method improves the performance of athletes. This method has attracted attention since 2011 and has become a popular tool in sports vision Training (Wilkins et al., 2018). This type of SVT training is based on the construct of skilled motor performance as the outcome of many visual subprocesses. (Erickson, 2020). SVT method used during natural training activities and in VR simulations that can reproduce sports scenarios to promote sports-specific visual cognitive abilities. (Erickson, 2018).

The theory that underpins SVT is that the limitation of vision, according to the samples received, forces individuals to make greater use of other sensations, such as kinesthetic awareness. Central vision Motor Sensitivity Skills such as short-term visual memory, prediction, dynamic vision, processing speed, and regulation have all been found to improve following periods of SVT (Wilkins et al., 2018). The prospect of improving visual and perceptual skills, given the constant desire to find marginal benefits in professional sports to get the advantage, it has become increasingly popular (Wilkins et al., 2018). SVT provides new and promising how to achieve this, but the literature is still in its infancy and more research is needed to confirm its usefulness as a training tool for coaches and athletes (Wilkins et al., 2018). It is assumed that participants who receive SVT will improve their visual and perceptual test performance (Wilkins et al., 2018).

According to the above survey of Wilkins et al. (2018) SVT has the potential to improve the visual response time of elite youth athletes. We found no evidence of the benefits of SVT in a wide range of other visual and perceptual skills, including attention, expectation, and hand-eye coordination (Wilkins et al., 2018). Nevertheless, the qualitative data from the interviews of this research, strongly supported the anecdotal evidence of SVT's

benefits. Further research is very important to expand this work and incorporate sports/motor performance measurements (Wilkins et al., 2018).

Adam Beavan et al. (2020) researched how restricted visual feedback affects performance in football specific skill assessments that incorporate the combination of football specific motor behavior and football-specific perceptual information (Beavan et al., 2020). According to their research SVT may be used to induce performance errors during practice to stimulate greater training effects, especially in more skilled athletes. (Beavan et al. 2020).

DISCUSSION

All researches that we studied highlighted the important role that vision plays in the performance of athletes, especially in football, helping them more or less dynamically to enhance their skills. The key points we pointed out are: human behavior always occurs in a dynamic context and requires the right balance between consistency (but not stereotype) and flexibility (but not random) movements (Williams et al., 2020). To produce just the right quantity of persistence and change in movement patterns, sports performers should perceive the spatiotemporal structure of the environment. As we've seen, without the ability to detect and understand, it is almost without doubt that athletes are unable to achieve the right blend of consistency and adaptability to cope with complex tasks such as interception behavior and movement in the air and on land. What is needed now from a sports perspective is more empirical working to extend standing under us in the process of perception and action and in particular, what coaches and teachers can do to help athletes grow their visual abilities and motor skills as the basis of sports expertise (Williams et al., 2020).

Williams et al. (2020) point out the nature and scale of the spatio-temporal demands on the sports performer. Furthermore, they emphasize that sports scientists can participate in these procedures as we strive to obtain better understanding of the behavior of human movements (Williams et al., 2020:377).

The science of improving visual skills to help athletes achieve the best performance levels is becoming increasingly important in training many sports. Performance analysis in sports science has undergone considerable changes recently, mainly with the increasing access and application of improved technologies in computer science (Millard et al., 2022). Visual abilities help football players as well as the inherent ability to improve more quickly. That visual fluency may explain why videos are an essential tool to help athletes bridge the gap between the mental image of a performance and the real one. A simple response time (to auditory or visual stimuli) is a major component of their performance. It is also an element of many game skills, such as these of the football goalkeeper (Reilly et al., 2000).

CONCLUSION

This thesis aims to strengthen the bibliographic research on vision training as the subject has not been sufficiently developed in the greek bibliography. More specifically, we studied the theory of vision training and its application to athletes in the field of football referring to specific surveys. Some theories and opinions were developed regarding various techniques of vision training on the vision of soccer players on the field. More specifically, we studied how VT guides athletes' bodies in how and when to react to the information they receive as well as how they can behave and use their vision on the field and during competition.

In conclusion, through the specific studies, emerged the beneficial effect of the application of vision training on the performance of athletes in the field of football, which leads to its increasing application in training programs. Furthermore, VT is included every day more and more in the bibliographic research and constantly inspires the writing of more scientific books.

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