Journal of Physical Education and Sport ® (JPES), 18(1), Art 23, pp. 175 - 183, 2018
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

The use of eye tracking glasses in Basketball shooting: a systematic review

RUI MARQUES[1,2,3], FERNANDO MARTINS[1,3], RUI MENDES[1], MANUEL COELHO E SILVA[2], GONÇALO DIAS[1,2]
[1]Instituto Politécnico de Coimbra, IIA, ESEC, ROBOCORP, ASSERT, PORTUGAL
[2] Universidade de Coimbra, FCDEF, CIDAF, PORTUGAL
[3] Instituto de Telecomunicações, Delegação da Covilhã, PORTUGAL

Published online: March 30, 2018
(Accepted for publication January 30, 2018
DOI:10.7752/jpes.2018.01023

Abstract:
Sports performance is related to cognitive processes that precede the motor task to be developed. In this way, the coupling between visual information and motor behavior has a major importance in filtering the visual information, necessary to the accomplishment of the motor task to be executed, ignoring 'accessory' stimuli. In this field, this essay has the goal of achieving a systematic review about past studies in the context of basketball shooting. We bring to you some evidence that support the applicability and efficiency of Eye Tracking Glasses systems in the analysis of visual attention in basketball shooting, emphasizing the concept of Quiet Eye, interconnected with anxiety and occlusion of vision. The results of the studies demonstrate the importance of the use of Eye Tracking Glasses for the evaluation/intervention in the process of visual attention training related to efficiency in shooting.
Key words: Eye tracking, quiet eye, basketball, jump shot, fixations, attention.

Introduction

Vision, in a wide sense, is a natural 'process' that allows us to interact with the surrounding environment. Seen this way, to better understand the phenomenon of vision, one uses visual tracking systems (Eye tracking Glasses, ETG) that enable us to study the position of the eyes and the optical movement (Holmqvist et al., 2011). These systems also make possible (Table 1) the analysis of underlying dynamics and mechanisms to the cognitive processes of the motor tasks to be performed (Discombe & Cotteril, 2015), namely measuring and analyzing the perception of a certain stimulus in relation to the position of the head. For its part, ETG measure the speed of the eye-pupil movements and detect the moment when fixations emerge, being even capable of detecting eye-pupil movement due to the capacity of the cornea in reflecting infrared light. Therefore, the perceptive ability of a given phenomenon such as, for example, basketball shooting, with the basket at different heights and distances from the visual range of the player, can be analyzed in real and ecological context of game or, on the other hand, in laboratorial scenario (cf. Afonso, Garganta, Williams, & Mesquita, 2010; Duchowski, 2002; Mele & Federici, 2012).

Eye-pupils need to focus a certain point so that we can make out colors, faces, writing, etc. In this case, the act of focusing is called fixation. Fixations may be defined as eye movements that stabilize the retina on an object or area of interest (Duchowski, 2007). These can be associated to the processes of attention (Afonso et al., 2010; Discombe & Cotterill, 2015). We point out that not all fixations are automatically perceived. Nevertheless, a stimulus that catches our attention has a greater probability of being more easily understood (Mele & Federici, 2012). For instance, if we move our eyes, we are potentially calibrating and directing our attention towards a determined direction (Gonzalez, Causer, Miall, Grey, & Humphreys, 2017).

The coupling between visual information and motor behavior has been studied in motor abilities connected to basketball, namely in the stabilization of the eyes and head of the player in relation to the target (e.g., the basket) (Ripoll, Bard, & Paillard, 1986), in tracking, number and duration of fixations in free throwing (de Oliveira, Oudejans, & Beek, 2008; Harle & Vickers, 2001) and in visual behavior under the effect of anxiety (Vine, Moore, & Wilson, 2014; Vine & Wilson, 2011; Wilson, Vine, & Wood, 2009), situation which is closely related to the interest of the individual and to the allocation of attention (Afonso et al., 2010; Mann, Williams, Ward, & Janelle, 2007).

Vickers (1996) defined visual information of the shooter as being the information obtained through movement of the head and eyes while preparing to execute a motor task. In the same way, Gauthier, Semmlow, Vercher, Pedrono and Obrecht (1991) stated that before basket shooting there is a potential eye orientation relatively to it as to better tune and calibrate the process of decision taking. Besides, the movement of the eyes

Corresponding Author RUI MARQUES, E-mail: rcamarques04@gmail.com

normally precedes the movement of the head. These authors defend that the eyes look for the basket and the head follows that movement due to its inertia. In addition, the results of the study by Ripoll et al. (1986) suggest that there are significant differences between experienced players and inexperienced ones in relation to the fixation of the eyes in the objective and that the stabilization of the binary head/ eyes is fundamental for the success of the basketball shoot. On this basis, the knowledge from the movement of the eyes enables the perception of the mechanisms of relevant acquisition for the control of certain motor actions. This being, the 'counting' of visual information can be obtained through records of eye movements, which provide data about central vision (e.g., number of fixations, duration of the fixations and saccades).

Table 1. Definition of ETG measures. Adapted from Lai et al. (2013).

Measures	*Definition*
Temporal	
Total fixation duration	Total time spent on fixations
Gaze duration	Total fixation duration within a word or an Areas of Interest (AOI)
Average fixation duration	Mean of fixation duration on each AOI (i.e., Gaze duration mean)
First fixation duration	Time spent on the first fixation
Time to first fixation	Time spent from stimuli onset to the first fixation arrival
Revisited fixation duration	Sum of revisited fixation durations within an AOI
Proportion of fixation duration	Proportion of time fixated on an AOI compared to the total fixation durations or total reading time of a whole
task Saccade duration	Sum of saccadic time spent within an AOI
Total reading time	Total time spent for a reading task or spent within an AOI
First pass time	Time spent for the first entering of an AOI until leaving
Re-reading time	Sum of revisited time spent within an AOI
Spatial	
Fixation position	Location of a fixation
Fixation sequence	Sequence of fixation allocations on AOIs
Saccade length	Distance between two consecutive fixations
Scanpath pattern	Pattern of fixation sequences
Count	
Total fixation count	Total number of fixations counted in an AOI or in a task
Average fixation count	Average fixation count on each AOI
Revisited fixation count	Sum of revisited fixations count within an AOI
Probability of fixation count	Probability of fixation count within an AOI compared to the number of fixations overall
Saccade count	Total number of saccades counted within an AOI
Inter-scanning count	Number of fixation transactions between AOIs

In the last years, innumerous studies were carried out (e.g., Causer, Holmes, & Williams, 2011; Sáez-Gallego, Vila-Maldonado, Abellán, & Jordán, 2015; Timmis, Turner, & van Paridon, 2014) in different types of sports which show precision movements (e.g., rifle shooting, basketball shooting and throwing darts, as well as football kicking and handball). This way, Vickers (1996) carried out a study where they analyzed the movement of free throw in basketball, having defined the concept of quiet eye (QE) as the period of time that goes from the beginning of the last fixation on target (rim or backboard) to the first observed movement of the upper limbs during the action of shooting. The QE onset occurs before the beginning of movement and the QE offset occurs when eyesight is off from target more than 3º of visual angle with a minimum of 100 ms. The fact that the QE precedes the beginning of the movement presupposes that this last fixation is used to process and define parameters of the action to be executed (Gonzalez et al., 2017). The process of QE is implicit relatively to the performance of experts in a wide variety of aiming tasks. Considering, too, that longer periods of QE are associated with better levels of motor performance. This being, QE can be considered as an integrating part of specialized motor activities (Vine et al., 2014).

In this varied scope, the current study has the purpose of carrying out a revision of the studies made using Eye Tracking Glasses in basketball shooting.

Methods

The bibliographical research was made with the objective of identifying published articles about the topic in the following database: *PUBMED, ScienceDirect, SPORTDiscus with Full Text, APA PsycNET, SciELO, Google Scholar* and *b-on*. The articles were selected, combining the following describers: gaze behavior AND visual control AND quiet eye AND basketball OR jump shot AND fixations.

Transversally, the selected articles were analyzed by two assessors in relation to the following criteria of inclusion for revision: i) published between January 1st 2006 and August 31st 2017; ii) written in English and Portuguese; iii) ones using ETG; iv) related to basketball shooting. PhD essays were left out.

The process of selecting the articles for sample went according to the following stages (Figure 1): i) research of describers in the database mentioned above; ii) exclusion of published work outside the adopted time frame; iii) exclusion of articles in duplicate; iv) reading of the summaries; v) reading and critical evaluation of the articles.

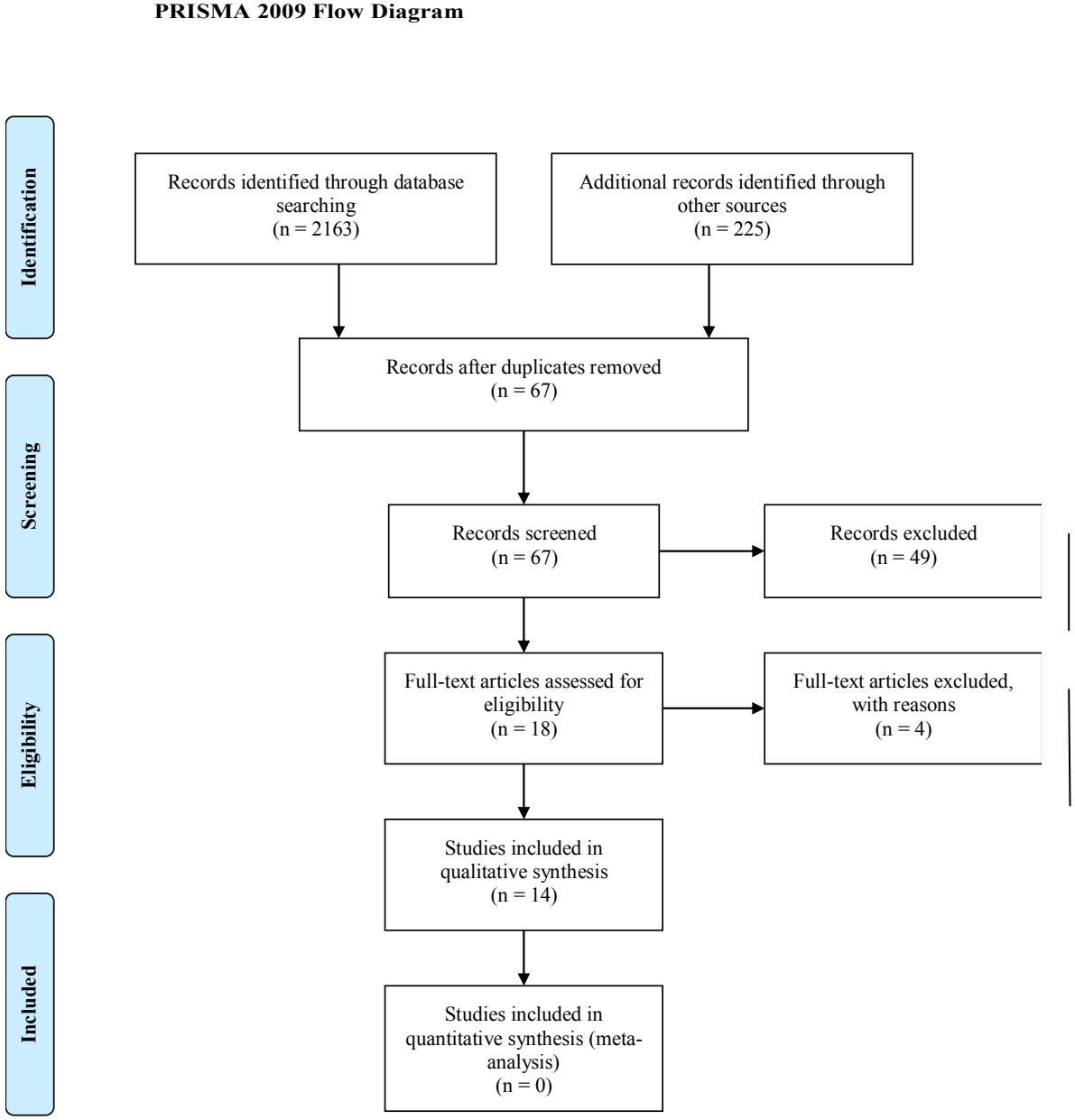

Fig. 1. Prisma Diagram. Adapted from Moher, Liberati, Tetzlaff e Altman (2009).

Results

The initial search resulted in 2388 titles of articles which after applying the criteria for inclusion and exclusion of works resulted in a final sample that had into account 14 articles (Table 2), published in the referred databases. From the analysis it was possible to verify several experimental designs in the field of research with ETG in basketball shooting. It is important to point out that some studies focus simultaneously on more than one question of research, standing out studies that analyze:

1. relationship between QE, anxiety and focus of attention (Rienhoff, Fischer, Strauss, Baker, & Schorer, 2015; Vine & Wilson, 2011; Wilson, 2010; Wilson & Vine, 2009; Wilson, Wood, & Vine, 2009);
2. occlusion of vision (de Oliveira, Huys, Oudejans, van De Langenberg, & Beek, 2007; de Oliveira, Oudejans, & Beek, 2006; Oudejans, Heubers, Ruitenbeek, & Janssen, 2012);
3. QE in jump shot and/or in free throw (de Oliveira et al., 2008; Fischer et al., 2015; Steciuk & Zwierko, 2015; Zwierko, Popowczak, Wozniak, & Rokita, 2016);
4. QE and jump shot with or without defense (Klostermann, Panchuk, & Farrow, 2017);
5. actions that precede the shooting (Oudejans, Karamat, & Stolk, 2012).

Relatively to the studied motor ability: *i)* 5 articles analyzed jump shots; *ii)* 5 articles analyzed free throws; *iii)* 2 articles analyzed jump shots and free throws; *iv)* 1 article analyzed shooting from a wheelchair; *v)* 1 article analyzed free throwing and throwing darts.

Table 2. Selected articles

	Authors	Year	Title
1	de Oliveira, Oudejans and Beek	2006	Late information pick-up is preferred in basketball jump shooting
2	de Oliveira., Huys, Oudejans, van de Langenberg and Beek	2007	Basketball Jump Shooting is Controlled Online by Vision
3	de Oliveira, Oudejans and Beek	2008	Gaze Behavior in Basketball Shooting: Further Evidence for Online Visual Control
4	Wilson and Vine	2009	Performing Under Pressure: Attentional Control and the Suppression of Vision in Basketball Free-Throw Shooting
5	Wilson, M., Vine, S. and Wood, G.	2009	The Influence of Anxiety on Visual Attentional Control in Basketball Free Throw Shooting
6	Wilson	2010	Gaze and Cognitive Control in Motor Performance: Implications for Skill Training
7	Vine and Wilson	2011	The influence of quiet eye training and pressure on attention and visuo-motor control
8	Oudejans, Heubers, Ruitenbeek and Janssen	2012	Training Visual Control in Wheelchair Basketball Shooting
9	Oudejans, Karamat and Stolk	2012	Effects of actions preceding the jump shot on gaze behavior and shooting performance in elite female basketball players
10	Fischer, Rienhoff, Tirp, Baker, Strauss and Schorer	2015	Retention of Quiet Eye in Older Skilled Basketball Players
11	Rienhoff, Fischer, Strauss, Baker and Schorer	2015	Focus of Attention Influences Quiet-Eye Behaviour: An Exploratory Investigation of Different Skill Levels in Female Basketball Players
12	Steciuk and Zwerko	2015	Gaze behavior in basketball shooting: preliminary investigations
13	Zwierko, Popowczak, Wozniak, Rokita	2016	Gaze Control in Basketball Jump Shots and Free Throws
14	Klostermann, Panchuk and Farrow	2017	Perception-action coupling in complex game play: Exploring the quiet eye in contested basketball jump shots

In general, the studies reported in Table 2 showed evidence of some crucial problems of research which will be briefly summarized in Table 3.

Tabela 3. Specification of the selected articles

	Authors	*ETG*	*QE*	*Purpose*	*Sample*	*Skill*	*Conclusions*
1	de Oliveira, Oudejans and Beek, (2006)	Plato LC glasses	No	Examination of the moment of the gathering of visual information	12 experts (7 high style and 5 low style)	Jump shot	Players with low jump shot style make the last fixation in the basket before vision occlusion and high jump shot style players make the last fixation in the basket under the ball after the period of occlusion of the vision.
2	de Oliveira., Huys, Oudejans, van de Langenberg and Beek (2007)	Plato LC glasses	No	Examine whether the basketball shooting is based on visual control rather than motor pre-programming	17 experts (8 ♂, 9 ♀)	Jump shot	Movement control based on visual information prevails in dynamic perceived motor tasks.
3	de Oliveira, Oudejans and Beek (2008)	ASL 501 (at 50Hz)	No	Comparison of visual behavior between players with high versus low style of shooting	6 experts (3 high style and 3 low style)	Free throw and jump shot	The basketball throw is mostly controlled by vision due to the use of visual information collected during motor skill.
4	Wilson and Vine (2009)	ASL (at 25Hz)	Yes	To test the Theory of Attention Control in a Sports Environment	10 experts	Free throw	Manipulation of anxiety resulted in significant reductions in the duration of the suppression period and in efficacy.

	Authors	*ETG*	*QE*	*Purpose*	*Sample*	*Skill*	*Conclusions*
5	Wilson, Vine and Wood (2009)	ASL (at 25Hz)	Yes	To test the Attention Control Theory using the QE period as an objective measure of attention control	10 experts	Free throw	Manipulation of anxiety resulted in significant reductions in the duration of the QE period and in efficacy. Anxiety impaired the QE period at the expense of more fixations, of shorter duration, to other sites.
6	Wilson (2010)	ASL	Yes	Influence of increased anxiety on attention control	Not reported	Free throw	The manipulation of anxiety showed significant reductions in attention control and free throw effectiveness.
	Authors	*ETG*	*QE*	*Purpose*	*Sample*	*Skill*	*Conclusions*
7	Vine and Wilson (2011)	ASL (at 25Hz)	Yes	To determine the efficacy of training in QE in attention interruptions associated with performing under pressure	16 novices	Free throw	The QE training group obtained better results in visual attention control and in the pressure test.
8	Oudejans, Heubers, Ruitenbeek and Janssen (2012)	Plato LC glasses	No	Effects of visual control training on wheelchair basketball players	10 expert wheelchair basketball players	Wheelchair throw	The results showed that visual control training is an effective method to improve wheelchair throw.
9	Oudejans, Karamat and Stolk (2012)	ASL (at 29,97Hz)	No	Effects of different actions preceding jump shot	8 experts	Jump shot after dribbling or receive a pass on dominant and non-dominant side	Efficacy percentages are higher when the player throws after receiving a pass on throw after dribble and are also higher when the preceding action is performed on the dominant side. In all pre-shooting conditions the players fixed their gaze on the target for a period long enough to succeed
10	Fischer, Rienhoff, Tirp, Baker, Strauss and Schorer (2015)	Arrington Research (at 30Hz)	Yes	Retention in motor abilities on QE and accuracy of shooting	21 skilled (14 medium-aged and 7 older-aged) 30 less-skilled (15 medium-aged and 15 older-aged)	Free throw (basketball) and throwing darts	Significant differences between age groups and expert groups on accuracy in both shooting tasks. There were no significant differences in duration of QE between the throws or age groups in the analyzed tasks
11	Rienhoff, Fischer, Strauss, Baker and Schorer (2015)	Arrington Research BS007 (at 30Hz)	Yes	Focus of attention: Internal vs external, take a influence in QE duration	9 experts, 9 advanced, 9 novices	Free throw	Significant differences in expertise and instruction. In the instruction relative to the external focus of attention there was a significant
	Authors	*ETG*	*QE*	*Purpose*	*Sample*	*Skill*	*Conclusions*
							decrease in free throw

	Authors	*ETG*	*QE*	*Purpose*	*Sample*	*Skill*	*Conclusions*
							performance compared to no instruction and internal instruction, but no significant differences between the internal instruction and no instruction. The results revealed significantly shorter QE durations for the external instruction condition than for the internal instruction condition and the non-instruction condition.
12	Steciuk and Zwerko (2015)	SMI ETG 2w (at 60Hz)	Yes	Relationship between visual behavior and shooting accuracy	6 experts	Jump shot	The visual behavior had a partial impact on the effectiveness of the jump shot, but there were no differences in the number of fixations points relative to the effectiveness of the launch.
13	Zwierko, Popowczak, Wozniak and Rokita (2016)	SMI ETG 2w	Yes	Examine the relationship between visual behavior and shooting effectiveness in dynamic and static situations	13 (experts; near-experts)	Jump shot and free throw	The effectiveness of the basketball shooting depends on the duration and frequency of the fixations. Expert players have less fixations on the target compared to near-expert players. In the free throw, after a fatigue induction test, the frequency of the fixations increased and their duration decreased.
14	Klostermann, Panchuk and Farrow (2017)	ASL (at 25Hz)	Yes	Comparison between expert players and intermediate players in situations with and without defense in QE	10 intermediate and 7 highly skilled	Jump shot after a drible	Longer QE times in defense situation relative to non-defense situations. Earlier QE onset show better efficacy outcomes.

Discussion

In general, the use of ETG appears to be a useful instrument for approaching different questions in the field of sports, given that they allow overlapping and crossing of the images obtained from a frontal video-camera with images of eye video-cameras. Besides, they also enable evaluations with greater ecological realism about the sensorial information used by athletes for pre-programming and executing certain movements.

Scientific production with ETC emerges as quite varied in the studies of isolated intervention or in the analyzed data (e.g., fixations, saccades, smooth pursuit, occlusion of vision). From the analyzed studies, three used glasses that allow occlusion of vision (Portable Liquid Crystal Apparatus for Tachistoscopic Occlusion - PLATO), the remaining having used glasses that enable the tracking of vision, at different standings and at different image processing speeds, 25Hz a 60Hz: ASL, SMI and Arrington Research.

Englert and Bertrams (2012), Martens, Vealey and Burton (1990) and Vickers and Williams (2007) defined anxiety as a discouraging emotional experience that can evolve during potential situations of threat in evaluation, with two components: cognitive (i.e. thoughts about the performance itself) and somatic (i.e. physiological changes, such as nervousness). It is extremely important to differ these two components of anxiety, for they can lead to diverse performances. This way, the studies of Wilson and Vine (2009) and Wilson et al. (2009) tested the theory of attentional control. The participants used ETG from ASL Mobile Eye Tracker (at 25 Hz) and prior to performing the free throws blocks, in two different situations of handling the level of anxiety, they described their state of anxiety by answering to a questionnaire on cognitive anxiety called Mental Readiness Form-Likert. In both studies, the authors found significant reductions of the duration of QE and of the

rate of success in free throwing, concluding that there was a negative influence of anxiety in motor performance due to interruptions in the control of attention.

In the line of thought of the last paragraph, Vine and Wilson (2011) found out that the participants subjected to QE training improved their performance in relation to the participants subjected only to technical training. They also realized that the participants subjected to QE training managed to maintain or improve their performance in situations of high anxiety, as with Wilson (2010), who examined the influence of anxiety rise in the control of attention during the execution of motor ability in free throw.

On one hand, Wilson et al. (2009) and Wilson and Vine (2009) verified that manipulation of anxiety during the period of vision suppression reduced the control of attention, given that the fixations were directed towards other visual stimuli (e.g., ball and/ or hands). This way, Rienhoff, Fischer, Strauss, Baker and Schorer (2015), who used ETG by Arrington Research BS007 (at 30 Hz) in their study, stated that external focuses of attention (ball) lead to a decrease in the duration of QE time, going against Ziv and Lidor (2015), and to a decrease of the efficiency in free throw as praised by Vickers (1996) and Williams, Singer and Frehlich (2002).

In relation to the studies that used equipment to analyze phenomena of occlusion of eyesight (PLATO), de Oliveira et al. (2006) came to the conclusion that in motor tasks as jump shot, the visual information was crucial for a good performance. In the line of the previous study, de Oliveira et al. (2007) showed that the control of movement based upon visual information prevailed in motor tasks of dynamic perception. Furthermore, Oudejans et al. (2012), in a study that analyzed basketball shooting from a wheelchair, confirmed these results, stating that visual control training can be an efficient method to improve this motor task.

On the other hand, the studies by de Oliveira et al. (2008) using ETG by ASL (at 50Hz) compared visual behavior between shooting players with high versus low style. The authors defined the shooting style of the participants in relation to the moment in which the ball enters their line of sight: high style – if the shooting hand is above the line of sight on target before the last extension of the elbow in shooting; low style – if the shooting hand is below the line of sight on target before the last extension of the elbow in shooting. The results by de Oliveira et al. (2008) confirmed the results by de Oliveira et al. (2006), stating that jump shooting is mostly controlled by vision, due to the use of visual information obtained during motor task, regardless of the shooting style.

In motor tasks of accurate shooting, is essencial to control the eyesight in relation to the target in order to allocate the final fixation on the target and keep it there long enough to guarantee levels of high precision. This said, Steciuk and Zwierko (2015), who used SMI ETC 2w (at 60 Hz) for their study, stated that visual behavior has a partial impact on the efficiency of jump shot, having not found significant differences between the frequency of fixations and the efficiency of this movement. Nevertheless, Zwierko et al. (2016), using ETC of the same brand, contradict this tendency when they refer that the efficiency of free throw depends on the duration and frequency of the fixations. These results are confirmed by Oudejans et al. (2012), who chose to use ETG by ASL (at 29,97Hz), mentioning that in all conditions that precede jump shots, players stare at the target during a long enough period in order to reach success and that the efficiency of shooting depends on the duration and frequency of those fixations.

Fischer et al. (2015), who used ETG BY Arrington Research (at 30Hz), concluded that in perception motor tasks, such as in free throw, the level of expertise is maintained in older athletes, this due to the lack of significant differences, in this study, in the duration of QE between shootings or age groups in the analyzed tasks.

Finally, in the only revised study which included defense situations, Klostermann et al. (2017), using ETG by ASL (at 25 Hz), found longer QE times in defense situations in relation to situation without defense and indicated that motor performances with earlier QE onset led to better results in terms of efficiency.

Conclusions

ETG record eyesight accurately while the athlete moves during the accomplishment of a motor task. During the execution of motor tasks, recorded data by ETG change constantly as the head moves (Ripoll et al., 1986), also causing coordinates x/ y to change.

Visual information relevant to the execution of a certain motor ability is detected before the last stage of the shooting movement (de Oliveira, 2007); Oudejans, (de Oliveira, 2007; Oudejans, van de Langenberg, & Hutter, 2002). Vickers (1996) defined that relevant visual information as being QE. In other words, the last part of fixation situated between the beginning of fixation and the first noticeable movement of the hands in shooting action, with 3º of visual angle with a minimum of 100ms, representing essential time for a concrete motor control, taking upon itself as an extremely important perceptive characteristic (Rienhoff et al., 2015), seeing that it may be considered as a variable of perception-action due to the fact that its beginning depends upon the beginning of a determined motor action (Vickers, 2007).

QE of experienced performers is significantly longer when compared to the one of less experienced ones. This means that experienced players manage to retain objects for longer periods, regardless of the conditions of the task, the beginning also being prior to the rest of the performers (Mann et al., 2007; Rienhoff et al., 2015). During the period of QE, the brain has time to process the visual information on which the eyesight endures (fixations). This causes the experienced player to have more time to program the motor ability in

question, possibly having a better performance and/or better decision taking (Vickers, 1996, 2009). This being the case and as basketball requires actions of precision (shooting at a target), there is the need for an emotional, cognitive and motor self-control in order to develop a selective attention, important action to accomplish the goal. This selective attention was classified by Schmeichel and Baumeister (2010) as being the ability to focus on a certain stimulus while ignoring others. This way, long QE duration can help fight the negative effects of anxiety, leading to a better performance.

Acknowledgements

This study was carried out within the scope of R&D Unit 50008, financed in part by grant number UID/EEA/50008/2013.

References

Afonso, J., Garganta, J., Williams, M., & Mesquita, I. (2010). Investigação em expertise decisional em jogos desportivos: Paradigmas, métodos e desenhos experimentais. *Revista Portuguesa de Ciências Do Desporto*, *10*(2), 78–95.

Causer, J., Holmes, P., & Williams, A. (2011). Quiet eye training in a visuomotor control task. *Medicine and Science in Sports and Exercise*, *43*(6), 1042–1049. de Oliveira, R. (2007). *Visual perception for basketball shooting*. (IFKB, Ed.). VU University Amsterdam, The Netherlands.

de Oliveira, R., Huys, R., Oudejans, R., van De Langenberg, R., & Beek, P. (2007). Basketball jump shooting is controlled online by vision. *Experimental Psychology*, *54*(3), 180–186.

de Oliveira, R., Oudejans, R., & Beek, P. (2006). Late information pick-up is preferred in basketball jump shooting. *Journal of Sports Sciences*, *24*(9), 933–940.

de Oliveira, R., Oudejans, R., & Beek, P. (2008). Gaze Behavior in Basketball Shooting. *Research Quarterly for Exercise and Sport*, *79*(3), 399–404.

Discombe, R., & Cotterill, S. (2015). Eye tracking in sport: A guide for new and aspiring researchers. *Sport & Exercise Psychology Review*, *11*(2), 49–58.

Duchowski, A. T. (2002). A breadth-first survey of eye-tracking applications. *Behavior Research Methods, Instruments, & Computers : A Journal of the Psychonomic Society, Inc*, *34*(4), 455–470.

Duchowski, A. T. (2007). *Eye tracking methodology: Theory and Practice* (2nd ed.). Springer.

Englert, C., & Bertrams, A. (2012). Anxiety, ego depletion, and sports performance. *Journal of Sport & Exercise Psychology*, *34*, 580–99.

Fischer, L., Rienhoff, R., Tirp, J., Baker, J., Strauss, B., & Schorer, J. (2015). Retention of Quiet Eye in Older Skilled Basketball Players. *Journal of Motor Behavior*, *47*(5), 407–414.

Gauthier, G., Semmlow, J., Vercher, C., Pedrono, C., & Obrecht, G. (1991). Adaptation of eye and head movements to reduced peripheral vision. *Oculomotor Control and Cognitive Processes*, 179–196.

Gonzalez, C. C., Causer, J., Miall, R. C., Grey, M. J., & Humphreys, G. (2017). Identifying the causal mechanisms of the quiet eye. *European Journal of Sport Science*, *17*(1), 74–84.

Harle, S., & Vickers, J. (2001). Training quiet eye improves accuracy in the basketball free throw. *The Sport Psychologist*.

Holmqvist, K., Nyström, M., Andersson, R., Dewhurst, R., Jarodzka, H., & Weijer, J. Van De. (2011). Eye Tracking: A comprehensive guide to methods and measures.

Klostermann, A., Panchuk, D., & Farrow, D. (2017). Perception-action coupling in complex game play: Exploring the quiet eye in contested basketball jump shots. *Journal of Sports Sciences*, *414*(July), 1–7.

Lai, M. L., Tsai, M. J., Yang, F. Y., Hsu, C. Y., Liu, T. C., Lee, S. W. Y., … Tsai, C. C. (2013). A review of using eye-tracking technology in exploring learning from 2000 to 2012. *Educational Research Review*, *10*(88), 90–115.

Mann, D., Williams, A., Ward, P., & Janelle, C. (2007). Perceptual-Cognitive Expertise in Sport: A Meta-Analysis. *Journal of Sport & Exercise Psychology*, *29*, 457–478.

Martens, R., Vealey, R., & Burton, D. (1990). *Competitive anxiety in sport*. Champaign, IL: Human Kinetics.

Mele, M. L., & Federici, S. (2012). Gaze and eye-tracking solutions for psychological research. *Cognitive Processing*, *13*(1), 261–265.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*, *339*, b2535–b2535.

Oudejans, R., Heubers, S., Ruitenbeek, J.-R., & Janssen, T. (2012). Training Visual Control in Wheelchair Basketball Shooting. *Research Quarterly for Exercise and Sport*, *83*(3), 464–469.

Oudejans, R., Karamat, R., & Stolk, M. (2012). Effects of Actions Preceding the Jump Shot on Gaze Behavior and Shooting Performance in Elite Female Basketball Players. *International Journal of Sports Science and Coaching*, *7*(2), 255–267.

Oudejans, R., van de Langenberg, R., & Hutter, R. (2002). Aiming at a far target under different viewing conditions: visual control in basketball jump shooting. *Human Movement Science*, *21*(4), 457–480.

Rienhoff, R., Fischer, L., Strauss, B., Baker, J., & Schorer, J. (2015). Focus of attention influences quiet-eye behavior: An exploratory investigation of different skill levels in female basketball players. *Sport,*

Exercise, and Performance Psychology, *4*(1), 62–74.

Ripoll, H., Bard, C., & Paillard, J. (1986). Stabilization of the head and eyes on target as a factor in successful basketball shooting. *Hum Mov Sci.*, *5*, 47–58Ripoll, H., Bard, C., Paillard, J. (1986).

Sáez-Gallego, N., Vila-Maldonado, S., Abellán, J., & Jordán, R. (2015). El comportamiento visual de bloqueadoras juveniles de voleibol y su relación con la precisión de su respuesta Visual behaviour of youth volleyball blockers and its relationship with their response accuracy Comportamento visual dos juvenis de bloqueio vole. *Cuadernos de Psicologia Del Deporte*, *15*(2), 143–154.

Schmeichel, B., & Baumeister, R. (2010). Effortful attention control. In B. Bruya (Ed.), *Effortless attention: A new perspective in the cognitive science of attention and action* (pp. 29–49). Cambridge, MA: MIT Press.

Steciuk, H., & Zwierko, T. (2015). Gaze behavior in basketball shooting: Preliminary investigations. *TRENDS in Sport Sciences*, *2*(22), 89–94.

Timmis, M., Turner, K., & van Paridon, K. (2014). Visual search strategies of soccer players executing a power vs. placement penalty kick. *PlOS ONE*, *9*(12), 1–16.

Vickers, J. (1996). Visual control when aiming at a far target. *Journal of Experimental Psychology: Human Perception and Performance*, *22*(2), 342–354.

Vickers, J. (2007). *Perception, Cognition, and Decision Training: The Quiet Eye in Action*. Champaign: Human Kinetics.

Vickers, J. (2009). Advances in coupling perception and action: the quiet eye as a bidirectional link between gaze, attention, and action. In M. Raab, J. Johnson, & H. Heekeren (Eds.), *Progress in Brain Research. Mind and Motion The Bidirectional Link between Thought and Action.* Vol. 174, 279–288.

Vickers, J., & Williams, A. (2007). Performing Under Pressure: The Effects of Physiological Arousal, Cognitive Anxiety, and Gaze Control in Biathlon. *Journal of Motor Behavior*, *39*(5), 381–394.

Vine, S., Moore, L., & Wilson, M. (2014). Quiet eye training: The acquisition, refinement and resilient performance of targeting skills. *European Journal of Sport Science*, *14*(S1), S235–S242.

Vine, S., & Wilson, M. (2011). The influence of quiet eye training and pressure on attention and visuo-motor control. *Acta Psychologica*, *136*(3), 340–346. https://doi.org/10.1016/j.actpsy.2010.12.008

Williams, A. M., Singer, R. N., & Frehlich, S. G. (2002). Quiet Eye Duration, Expertise, and Task Complexity in Near and Far Aiming Tasks. *Journal of Motor Behavior*, *34*(2), 197–207.

Wilson, M. (2010). Gaze and Cognitive Control in Motor Performance: Implications for Skill Training. *The Sport and Exercise Scientist*, (23), 29–30.

Wilson, M., & Vine, S. (2009). Performing Under Pressure: Attentional Control and the Suppression of Vision in Basketball Free-Throw Shooting. In C. Chang (Ed.), *Handbook of Sports Psychology* (pp. 277–296). Nova Science Publishers, Inc.

Wilson, M., Vine, S., & Wood, G. (2009). The influence of anxiety on visual attentional control in basketball free throw shooting. *Journal of Sport & Exercise Psychology*, *31*(2), 152–168.

Wilson, M., Wood, G., & Vine, S. (2009). Anxiety, attentional control, and performance impairment in penalty kicks. *Journal of Sport & Exercise Psychology*, *31*, 761–775.

Ziv, G., & Lidor, R. (2015). Focusing attention instructions, accuracy, and quiet eye in a self-paced task an exploratory study. *International Journal of Sport and Exercise Psychology*, *13*(2), 104–120.

Zwierko, T., Popowczak, M., Wozniak, M., & Rokita, A. (2016). Gaze Control in Basketball Jump Shots and Free Throws. *Research Quarterly for Exercise and Sport*, *87*(1), S99–S99.