Int J School Health. 2019 July; 6(3):e94951. doi: 10.5812/intjsh.94951.

Published online 2019 September 15. **Research Article**

Effect of Technical and Quiet Eye Training on the Gaze Behavior and Long-Term Learning of Volleyball Serve Reception in 10 to 12-Year-Old Female

Fatemeh Sharafian [1], Mehdi Shahbazi [1,*] and Shahzad Tahmasebi Boroujeni [1]

[1] Faculty of Physical Education and Sport Sciences, University of Tehran, Tehran, Iran

[*] *Corresponding author*: Faculty of Physical Education and Sport Sciences, University of Tehran, Tehran, Iran. Email: shahbazimehdi@ut.ac.ir

Received 2019 June 04; **Revised** 2019 August 27; **Accepted** 2019 September 02.

Abstract

Background: A quiet eye is the final fixation or tracking before moving on, which requires concentration and attention, and is an effective way of teaching interceptive tasks.

Methods: In the current semi-experimental study, 20 volunteer female students from a volleyball center of Shiraz District 1 (mean age = 12.10, SD = 0.718) were selected as the participants from February 2017 to February 2018. After taking the pre-test, they were randomly divided into two groups of 10 (technical training and quiet eye training). The intended task was to receive volleyball serve with the forearm from three receiving areas of the mini-volleyball court. To measure the accuracy of the volleyball serve reception, a volleyball Serve Reception Test by forearm was used in mini-volleyball court. Ergoneers eye tracking (EET) was used to record the visual data. After the pre-test, the participants took part in 9 separate training sessions three sessions a week, and 48 hours after the last training session, the first retention test and one month later the second retention test was performed. Data were analyzed by 2 $\times$ 3 mixed analysis of variance (ANOVA) of quiet eye duration and performance, using SPSS software at a significant level of $P \leq 0.05$.

Results: The results showed that the mean performance of the quiet eye training group increased from 4.30 $\pm$ 1.76 in pre-test to 11 $\pm$ 1.76 in the first retention and 12 $\pm$ 2 in long-term retention in comparison to the technical training group ($P = 0.007$). However, there was no significant difference between the mean quiet eye duration of the quiet eye and technical training groups ($P = 0.512$).

Conclusions: It seems that quiet eye training has a significant effect on the long-term learning of beginners compared to technical training, but it does not have a significant difference in the duration of beginners' quiet eye compared to technical training.

Keywords: Quiet Eye Training, Perceptual-Cognitive Skills, Long-Term Learning, Volleyball, Female Students

1. Background

Quiet eye (QE) is a strong component of perceptual mastery, and is a sign of a specific behavior of the gaze before moving on, and it is shown as a feature of skill and expertise in the interceptive timing tasks, such as volleyball and badminton serve reception and football goalkeeping, and targeting tasks, which occur as the final fixation or tracking gaze that is located on a specific location or object in the task space within 3 degrees of visual angle (or less) for a minimum of 100 ms (1). Conceptually, the quiet eye represents the time required for organizing neural networks and visual parameters responsible for directing and controlling visual attention (2). During this period, sensory information is combined with the pre-program and controls the appropriate movement response online (3).

Regarding the inhibition hypothesis, the quiet eye's longer duration, by the need to inhibit excessive movement changes in skilled individuals, causes optimal changes during preparation as well as during movement (4). Quiet eye training includes two components of external attention training and visual feedback in action (5). In addition, the external attention with respect to the constrained action allows automatic control of the motor system and subsequently, increases the effectiveness of the movements (6). Despite numerous studies on the effectiveness of the focus of attention, some studies have shown that visual information can moderate the benefits of external attention (7); however, other studies have suggested that the benefits of external attention are independent of the vision (8-11).

The benefits of training and quiet eye training in children are shown in many studies. In 2014, a study by Miles and his colleagues on throwing and catching in children showed that the extended pre-throw QE fixation on the

wall provided the information to prepare the interception attempt (12). In a study conducted by Miles, Wood, Wine, Vickers, and Wilson in 2015 on throwing and catching through two types of technical and QE training on children aged 10 - 8, in addition to showing that the duration of the QE training group was longer and faster than the technical training group, the improvement in the performance of the QE group was comparable to the technical group in both tests; the first and second retention, following 6 weeks of no training (3).

The observed effect of quiet eye training interventions on skilled and nearly-skilled individuals in several studies, including volleyball (5), basketball (13), and shooting (14) indicates an increase in the QE duration in skilled and nearly-skilled individuals. Also, the effectiveness of attention focus expressed by the duration of a longer quiet eye with a better performance and longer duration of quiet eye in the retention and transference tests through the use of training interventions in beginner subjects was shown in the studies of Vine et al. (15) and Moore et al. (16). Nevertheless, a study was conducted by Klostersmann in 2018 on a non-dominant underhand throwing in two groups of blocked and random training with QE training, which both groups showed superior performance in post-test and retention test when compared to pre-test and longer QE duration in post-test when compared to the pre-test. However, the QE duration dropped to baseline values at retention (17).

Despite numerous studies on the effectiveness and efficacy of quiet eye training, few studies have looked at the effectiveness of quiet eye training interceptive skills as well as specialized sports skills in children. Therefore, it is necessary to investigate how quiet eye training affects the performance and learning of children at this age in specialized and interceptive exercise.

2. Methods

The sample size of this study was determined based on optimal sample size calculations ($f = 0.25$, $1 - \beta = 0.90$, $\alpha = 0.05$ (18), a sample of 20 female students of a volleyball center in Shiraz District 1 (12.10 age mean, SD = 0.718) enrolled from February 2017 to February 2018. All participants were physically and mentally healthy and right-handed and had a natural vision (20/20), and well-trained in the forearm and claw skills, but were beginners in volleyball serve reception the forearm and sending it to the passor.

All the participants received 20 volleyball services as test terms. We applied some criteria such as the age range (10 to 12 years), normal vision based on Snellen test of sight, get score below 40% as the inclusion criteria. We also excluded any participant who did not normal vision, and earned a score of over 40% in service receiving skill. The informed consent form was received from them and their parents. In the study, the task was to receive volleyball serves conducted in a standard mini-volleyball court with a length of 12 and a width of 6 meters and a net of 2 meters in height (19). To measure the accuracy of volleyball serve reception skill, the volleyball serve reception test was used. This test included receiving 20 volleyball serves with forearm (10 simple serves and 10 smash serves) in the three designated areas (1-3-4) of the mini-volleyball court and sending it to the passor area, which the accuracy of volleyball serve reception and sending it was reported as a percentage of the total 20 received serves in the pre-test and the first retention and long-term retention tests.

In 2017, the reliability of this test was evaluated by the researcher with a test-retest ($P < 0.05$, $r = 0.71$, $n = 10$) and its validity was assessed by comparing the advanced and beginner groups ($P = 0.001$, $t = 5.81$, $df = 18$). Also, the QE duration of subjects in the pre-test and first and second retention tests was measured using Ergoneer Eye Tracking (Dekablis professional wireless of the Ergoneers company of Germany), which recorded gaze at every moment at a frequency of 6 Htz. The system included glasses equipped with a camera and a portable recorder. The data achieved were transmitted through a wireless system to a computer via a videotape to the computer, and Dlab software and the manufacturer's information processing system were used to record eye movements and changes. Also, a high-speed camera from the side view was used to record the movements of subjects and adapt it to eye cameras to calculate QE in all three tests. The first move of the foot of the service recipient at the moment of movement to receive the served ball was considered the quiet eye duration (QE).

For all serves to be identical in both groups, the ball flight time was calculated in all tests (pre-test and first and second retention tests) and all were reported to be similar ($P = 0.873$). After pre-test, the samples were allocated numbers from one to twenty, then 10 numbers were randomly selected and assigned to the technical group and the remaining ten numbers were assigned to the quiet eye group. Then the volleyball serve reception skill with forearm was taught with video by a skilled player accompanied by a verbal instruction to both groups; the instruction of the technical training group was based on standard training and movement were taught to the subjects to learn the volleyball serve reception skill. On the other hand, the QE training group, in addition to the standard training of the volleyball serve reception skill, was taught (visual) gaze behavior in three phases of volleyball serve reception with forearm to optimize the fixation, tracking, and control of the ball.

Both groups participated in nine sessions of 90 min-

utes, and in each session, each participant performed 5 blocks of 10 attempts to receive volleyball serve with a 2-minute rest interval after each block. In the technical training group, the receptions were done in a different direction and distance from the net (near, far) on the opposite court. The training was first performed in a blocked manner and then performed randomly; on the other hand, the quiet eye group training was performed based on Vickers' 7 steps of QE training (1), as follows:

1- In the first step, the skilled sample's eye pattern information was defined; it emphasized eye fixation on the server's point of contact of the hand with the ball and then tracking the ball from the start of the ball flight until it was about 2 meters in front of the receiver and then retaining the eye in the front zone of the court and not distracting it until the ball reached the passor area.

2- In the second step, the participants' point or gaze behavior was recorded by eye tracking in 20 pre-test serve receptions to provide visual feedback in practice and compare it with the skilled sample eye pattern.

3- In the third step, the QE group was trained by skilled individual's performing film, as well as skilled sample eye pattern film, to control the gaze behavior, which was based on the movement information and eye pattern mentioned in the first step.

4- In the fourth step, the subjects' QE visual information into practice in the second step was compared to the skilled individual's QE using two side-by-side QE videos, and questions about the location and duration of the QE that tracked the ball before the first step to receive the service and their differences were asked from the subjects.

5- In the fifth step, drawing on decision-making training, subjects were asked which one of the features of the QE eye pattern in the first step would like to improve.

6- In the sixth step, the volleyball serve reception training sessions were performed in different forms and distances first in a blocked and then random manner. These exercises were designed to improve early recognition and detection of the ball at the moment of serve and track, which included:

I- Tracking the return of the tennis ball thrown onto the wall and receiving it with a forearm from a distance of 2 meters from the wall to increase focus and visual attention.

II- Tracking and calling out and receiving mini volleyball ball on which numbers 1 to 20 were written and initially served from a distance of 2 meters and then 4 and 6 meters from the net on the opposite court.

III- Tracking and calling out and receiving the ball was served from behind a barrier.

IV- Tracking and calling out the numbers written on the ball and receive it after the voice of the coach's whistle and full body rotation.

V-. Receiving the serve with forearm along with calling out the numbers on the ball with a loud voice and fit and proper guard on the court and sending it to the passor.

7- In the seventh step, QE was evaluated during all the sessions as competitively. Then by QE evaluation in the first and second retentions, the QE test was continuously evaluated.

Descriptive statistics were used to analyze the mean, standard deviation, and data distribution. The Shapiro-Wilk test was used to determine the normality of the data. Leven's test was used to examine the homogeneity of variance.

To analyze the performance of volleyball serve reception and quiet eye duration, mixed ANOVA 2×3 was used in the pre-test, first-retention, and second-retention stages. Bonferroni's post hoc test was used to determine the significant difference in the stages of the test. Data analysis was performed using SPSS software (version 23) at a significant level of $P \leq 0.05$.

3. Results

A total of 20 individuals participated in this study, All of them had a normal vision (20/20). Their mean age was 12.10 $\pm$ SD = 0.718, mean height was 155.25 $\pm$ SD = 7.887, mean weight was 48.95 $\pm$ SD = 8.846. Regarding independent *t*-test, there was no significant difference between the two groups in terms of demographic variables age (P = 1), height (P = 0.493), weight (P = 0.206). All participants were beginners in the skill of receiving volleyball service. Descriptive statistics showed that the mean performance of the quiet eye group increased from 4.30 $\pm$ 1.76 in pre-test to 11 $\pm$ 1.76 in first retention and 12 $\pm$ 2 in long-term retention rather than technical training group (pre-test = 4.20 $\pm$ 2.3, first retention = 8.50 $\pm$ 2.27, long term retention = 8.60 $\pm$ 2.83) (Figure 1). Also, the normal distribution of the two variables of performance and the duration of quiet eye were proved in the two groups of technical and quiet eye by the Shapiro-Wilk test ($P \geq 0.05$). Moreover, in leven's statistics, the homogeneity of variances was established in the two groups based on mentioned variables ($P \geq 0.05$).

Based on the results of 2×3 mixed ANOVA test, the results of the performance of the volleyball serve reception showed that assumption of Mauchly's test of sphericity is established (P = 0.582). The results showed that the main effect of the performance test on volleyball serve reception is significant ($F(2, 36) = 56.27$, P = 0.001, $\eta^2 p = 0.758$). The results of paired comparison of Bonferron's post hoc test in the technical group from pre-test to the first retention (P = 0.007) and the quiet eye group (P = 0.001) showed a significant increase in the performance of serve reception; and from the pre-test to the second retention in the technical

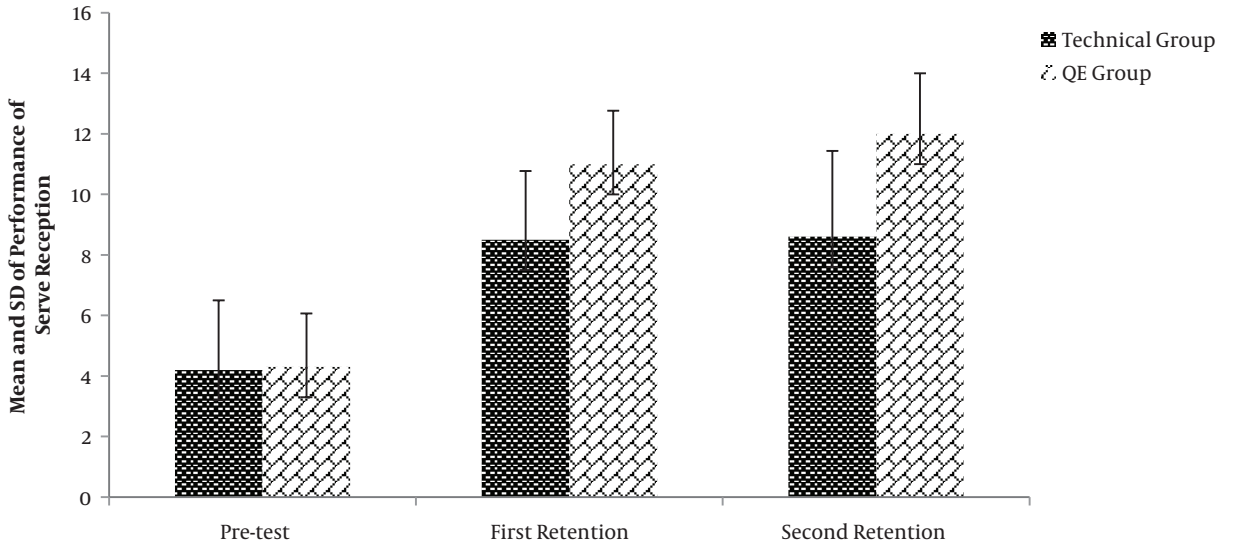

Figure 1. Mean and standard deviation (SD) of volleyball serve reception in the two groups of technical and quiet eye training are shown

group (P = 0.006) and in the quiet eye (P = 0.001) showed a significant increase; and from the first retention to the second retention in the technical group (P = 1) and the quiet eye group (P = 0.612) the difference was not significant. The main effect of the group performance on serve reception showed a significant difference between the groups (F(1.18) = 9.359, p = 0.007, η^2p = 0.342). Also, the interactive effect of the group and the performance test on serve reception was significant (F (2.36) = 3.658, P = 0.036, η^2p = 0.169).

Furthermore, descriptive statistics showed that there was no difference between mean quiet eye duration of the quiet eye training group with mean quiet eye duration of the quiet eye training group with 414.62 $\pm$ 67.68 in pre-test, 539.3 $\pm$ 25.36 in the first retention, 475.77 $\pm$ 35.58 in long-term retention and the technical group with 399.95 $\pm$ 24.376 in pre-test, 549.12 $\pm$ 35.29 in the first retention and 461.75 $\pm$ 35.68 in long-retention) (Figure 2). Also, the results of 2 $\times$ 3 mixed ANOVA test of the duration of quiet eye showed that the assumption of Mauchly's test of sphericity was proven (P = 0.319). The main effect of the test on the duration of quiet eye was significant (F(2.36) = 53.386, P = 0.001, η^2p = 0.748).

The results of paired comparison of Bonferroni's post hoc test showed that the duration of quiet eye in the technical group (P = 0.001) and in the quiet eye group (P = 0.001) increased significantly from the pre-test to the first retention, and there was a significant decrease in its level in both technical (P = 0.003) and quiet eye group (P = 0.001). The duration of the quiet eye also decreased from pre-test to the second retention in the technical group (P = 0.007) and in the quiet eye group (P = 0.139); however, none of the main effects of the group (F(1,18) = 0.449, P = 0.512, η^2p = 0.024,), and the interactive effect of the group and the duration of quiet eye did not show a significant difference (F(2,36) = 0.566, P = 0.573, η^2p = 0.030) (Figure 2).

4. Discussion

The purpose of this study was to investigate the effect of quiet eye and technical training on the duration of QE and long-term learning of volleyball serve reception in the beginning children aged 10 to 12 years old. The results showed improvement in the performance of both technical and quiet eye groups from pre-test to the first and second retention. Also, the performance of the two groups did not show a significant difference in the first and second retention tests. Generally, the performance of the serve reception in the quiet eye group in the first and second retention was significantly better than the technical training group, which is in line with the research conducted by Vickers, Miles, Wine, and Wilson in 2015 on training interceptive and targeting throwing and catching in children (3).

Regarding the dual components of quiet eye training (5), and according to the available evidence of the effect of external attention training on motor learning of specific groups, including children aged 9 - 12 (20), the results of the present study support Wolf and McNevin's constrained action hypothesis that predicts performance in the external attention condition reduces conscious intervention in

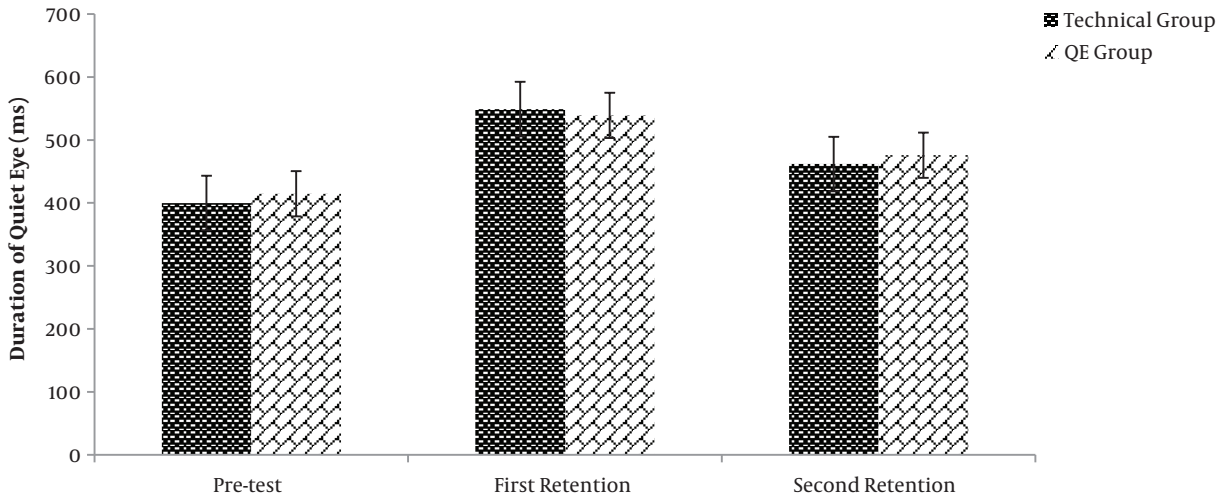

Figure 2. Mean and standard deviation (SD) of the duration of quiet eye in the volleyball serve reception in the two groups of technical and quiet eyes training are shown

controlling the coordination of movement and leads to increased learning and performance (21).

The second goal of the study was to investigate changes in the duration quiet eye in volleyball serve reception skill, which showed that the duration of the quiet eye in both technical and quiet eye groups significantly increased from pre-test to retention phases. However, it was not maintained from the first retention in the second, and the increase in the duration of quiet eye in the first retention in both technical and quiet eye group did not differ significantly from each other.

To interpret this issue, it can be advocated that in both groups, taking directions and controlling the gaze and attention as hidden learning occurs along with skill learning, and there is no difference between the duration of quiet eye in the two groups. On the other hand, according to the Clustersman inhibition theory (4, 22), which states that the longer duration of quiet eye, owing to the need to inhibit excessive movement changes in skilled individuals, and owing to the extended task-solution space created by the training, leads to optimal changes and choices and prevents undesirable selection during preparation and motion performance in the skilled individuals (4); so it seems that most likely the effect of a quiet eye period is related to the individuals' level of skill (23). Nevertheless, the subjects were beginners in this study.

From the results of this study, it is concluded that volleyball serve reception skill and its purposeful sending to the passor is a perceptual-motor skill that requires high levels of cognitive skills such as attention, concentration, pattern recognition, prediction and decision making, finding perceptual-cognitive training methods and decision-making training, of which the quiet eye training can play a positive role in improving learning and preserving it in long-term memory.

Considering the overall results of this research, the present study provides some useful information regarding the effect of perceptual-motor training on cognitive enrichment and the use of decision-making training relative to simply behavioral training, in order to accelerate the learning of skills and, moreover, to consolidate this learning in long-term memory.

4.1. Limitations

Nutrition, rest, mental conditions and other physical, mental, and perceptual-cognitive activities of children were factors that could not be controlled in this research.

4.2. Recommendations

Based on the current conditions of the schools and gyms in the country, it is recommended that a study should be carried out with three groups, in which in addition to the two groups of technical and quiet eye, a group is added to carry out volleyball serve reception training solely through external attention focus training and exercises, without an eye tracker and visual feedback device, to differentiate it from the QE training group in order to generalize its results to schools and sports centers in the country.

4.3. Conclusions

According to the results of this study, there was no difference between the QE and technical training in the beginners in terms of the duration of quiet eye in both groups, and the gaze behavior (prolonging the duration of the quiet eye) in the course of learning skills, as the implicit learning occurred in both groups; however, the skill performance of the quiet eye group was significantly different from that of the technical group, which owing to the subjects' beginning level and the task difficulty, it can be attributed to the external attention focus training relative to the video visual feedback.

Footnotes

Authors' Contribution: This research is based on the Ph.D. thesis of Fatemeh Sharafian in the motor behavior field. Mehdi Shahbazi was the supervisor and Shahzad Tahmasebi Boroujeni was the advisor.

Conflict of Interests: It is not declared by the authors.

Ethical Approval: IR.SSRI.REC.1398.454.

Financial Disclosure: All authors of this research disclose any financial and personal relationships with participants or school boards that could inappropriately influence the work.

Funding/Support: There is no direct financial payment to the authors for the research or manuscript production by the sponsor of a product or service evaluated in this article.

References

1. Vickers JN. The Quiet Eye: Reply to sixteen commentaries. *Current Issues Sport Sci*. 2016;**2016**(1). doi: 10.15203/ciss_2016.118.
2. Vickers JN. *Perception, cognition, and decision training. The quiet eye in action*. Champaign, IL: Human Kinetics; 2007.
3. Miles CA, Wood G, Vine SJ, Vickers JN, Wilson MR. Quiet eye training aids the long-term learning of throwing and catching in children: Preliminary evidence for a predictive control strategy. *Eur J Sport Sci*. 2017;**17**(1):100–8. doi: 10.1080/17461391.2015.1122093. [PubMed: 27871220].
4. Klostermann A. Finale Fixationen, sportmotorische Leistung und eine Inhibitionshypothese: Mechanismen des "Quiet Eye". *Sportwissenschaft*. 2013;**44**(1):49–59. doi: 10.1007/s12662-013-0313-9.
5. Adolphe RM, Vickers JN, Laplante G. Laplante, The effects of training visual attention on gaze behaviour and accuracy: A pilot study. *Int J Sports Vision*. 1997;**4**(1):28–33.
6. Wulf G. Attentional focus and motor learning: A review of 15 years. *Int Rev Sport Exerc Psychol*. 2013;**6**(1):77–104. doi: 10.1080/1750984x.2012.723728.
7. Hodges NJ, Ford PAUL. *Skillful attending, looking and thinking. Bewegung und Training*. **1**. 2007. p. 23–4.
8. Abdollahipour R, Psotta R, Land WM. The influence of attentional focus instructions and vision on jump height performance. *Res Q Exerc Sport*. 2016;**87**(4):408–13. doi: 10.1080/02701367.2016.1224295. [PubMed: 27636712].
9. Sherwood DE, Lohse KR, Healy AF. Judging joint angles and movement outcome: Shifting the focus of attention in dart-throwing. *J Exp Psychol Hum Percept Perform*. 2014;**40**(5):1903–14. doi: 10.1037/a0037187. [PubMed: 24911011].
10. Land WM, Tenenbaum G, Ward P, Marquardt C. Examination of visual information as a mediator of external focus benefits. *J Sport Exerc Psychol*. 2013;**35**(3):250–9. [PubMed: 23798588].
11. McNevin NH, Wulf G. Attentional focus on supra-postural tasks affects postural control. *Hum Mov Sci*. 2002;**21**(2):187–202. [PubMed: 12167298].
12. Miles CAL, Vine SJ, Wood G, Vickers JN, Wilson MR. Quiet eye training improves throw and catch performance in children. *Psychol Sport Exerc*. 2014;**15**(5):511–5. doi: 10.1016/j.psychsport.2014.04.009.
13. Vickers JN. Control of visual attention during the basketball free throw. *Am J Sports Med*. 1996;**24**(6 Suppl):S93–7. doi: 10.1177/036354659602406S25. [PubMed: 8947439].
14. Causer J, Holmes PS, Williams AM. Quiet eye training in a visuomotor control task. *Med Sci Sports Exerc*. 2011;**43**(6):1042–9. doi: 10.1249/MSS.0b013e3182035de6. [PubMed: 21577082].
15. Vine SJ, Moore LJ, Cooke A, Ring C, Wilson MR. Quiet eye training: A means to implicit motor learning. *Int J Sport Psychol*. 2013;**44**(4):367–86.
16. Moore LJ, Vine SJ, Cooke A, Ring C, Wilson MR. Quiet eye training expedites motor learning and aids performance under heightened anxiety: The roles of response programming and external attention. *Psychophysiology*. 2012;**49**(7):1005–15. doi: 10.1111/j.1469-8986.2012.01379.x. [PubMed: 22564009].
17. Klostermann A, Kredel R, Hossner EJ. Quiet eye and motor performance: The longer the better? *J Sport Exerc Psychol*. 2018;**40**(2):82–91. doi: 10.1123/jsep.2017-0277. [PubMed: 29877138].
18. Klostermann A, Kredel R, Hossner EJ. The quiet eye without a target: The primacy of visual information processing. *J Exp Psychol Hum Percept Perform*. 2014;**40**(6):2167–78. doi: 10.1037/a0038222. [PubMed: 25314047].
19. Mehregan J. [Talent management in volleyball, six stages for teaching the world-class players]. *Specialist Media*. 2016;**146**. Persian.
20. Thorn JE. *sing attentional strategies for balance performance and learning in nine through 12 year olds [dissertation]*. Tallahassee: Florida State University; 2006.
21. Wulf G, McNevin N. Simply distracting learners is not enough: More evidence for the learning benefits of an external focus of attention. *Eur J Sport Sci*. 2003;**3**(5):1–13. doi: 10.1080/17461390300073501.
22. Klostermann A, Kredel R, Hossner EJ. On the interaction of attentional focus and gaze: The quiet eye inhibits focus-related performance decrements. *J Sport Exerc Psychol*. 2014;**36**(4):392–400. doi: 10.1123/jsep.2013-0273. [PubMed: 25226608].
23. Vickers JN. Visual control when aiming at a far target. *J Exp Psychol Hum Percept Perform*. 1996;**22**(2):342–54. doi: 10.1037/0096-1523.22.2.342.