THE EFFECTIVENESS OF DIFFERENT VISUAL SKILLS PROGRAMMES ON ELITE CRICKET PLAYERS

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***Abstract* :** *The effectiveness of visual training interventions for athletes has been questioned over the last few years. Few studies have shown the potential for generic visual skills to improve visual performance in the sport while most interventions seem to be unsuccessful. There is a paucity of studies involving elite performers exposed to visual training programmes, which are becoming popular in the sporting domain. This study aimed to investigate the effect of visual training on visual and cricket skills compared to a control intervention. Twenty-four male county cricket players were pre- and post-tested on 14 visual and 7 cricket tasks. Participants were randomly divided into four groups and underwent a six-week visual training programme consisting of practical drills (P), online training (O), Nintendo Wii games (W), or a control intervention (C). Analysis showed all experimental groups significantly improved from pre- to post-test, whereas the C group showed no significant improvement. The three vision training methods implemented were able to improve visual and cricket skills more than being exposed only to a control intervention. This supports suggestions that visual skills can improve through training. The improvement in cricket skills observed in this study suggests that improvements in visual skills might influence 'on-field' improvements in performance.*

Keywords *Vision, Visual perception, Cricket, Sports, Athletes, Training.*

Introduction :

Visual skills training has recently gained popularity in the sport thanks to the development of novel technological and methodological approaches. However, despite this increase in popularity, there is limited information about the scientific effectiveness of such training. Furthermore, the scientific literature is still lacking consensus on the effectiveness of visual skills training and/or any differences existing between and within athletics groups. A study by Wimshurst, Sowden, and Cardinale (2012) suggested that it is possible to improve the visual skills of Olympic-level athletes by implementing a visual training programme over a period of time. Similar research has shown that field hockey players could significantly improve their choice reaction time and functional field of view through training , cricketers who carried out visual training showed significant improvements in skills such as peripheral vision, ball skills, concentration, focus flexibility and coordination , and soccer, basketball, and handball players have shown improvements in near dissociated phoria and convergence motor fusion following an 8 week training programme.

There are relatively few examples of visual skills training interventions; however, the results have been promising. Calder investigated the effectiveness of two types of a training programme on a group of club-level hockey players. One group took part in a dedicated visual skills training programme, while the other group also received 'sport-specific visual awareness coaching'. The performance was measured on a range of visual skills as well as 22 basic hockey skills. The results showed that participants who just received visual skills training improved on two of the basic hockey skills (whereas a control group showed no improvement), but importantly the group who also received 'sport-specific visual awareness coaching' improved on 12 of the 22 basic hockey tests. Similarly, Kofsky and Starfield gave generalized vision training to experienced college level basketball players for 20 sessions over a five-week period. They found that general vision function improved in the experimental group and not the control group but, more interestingly, actual game performance also improved in the experimental group when compared to the control. In contrast, Abernethy and Wood trialed two generalized visual training programmes and compared them to a placebo group and a control group. Their participants were all novices and were pre- and post-tested on both visual skills and tennis related motor skills. No differences were found between the groups on any of the tasks, and the study concluded that such generalised vision programmes do not appear to provide the improvements in either basic visual function or motor performance that they claim. The main difference between these studies seems to be that Abernethy and Wood used novice participants whereas both Calder, and Kofsky and Starfield used highly experienced athletes who would perhaps be more motivated to improve their performance as they could see the benefits that would come with improved visual skills. To investigate the effects of a vision training programme on novices compared to experts, Quevedo and colleagues (Quevedo & Solé, Quevedo, Solé, Palmi, Planas, & Saona) used an unspecified vision training programme on both elite and novice precision shooters. With their elite group (Olympic team members) it was found that both visual function and shooting performance showed statistical improvement as a consequence of the intervention. However, their novice group showed no improvement in shooting performance above that of a control group despite an increase in visual acuity with the same intervention.

The above studies show promise for the use of visual training programmes for the improvement of sport-specific skills, however, there is little consensus or consistency over the methods used. Commonly reported measures to include: practical drills taken from popular sports vision texts books non-sport specific eye exercises such as those designed by Revien's 'Eyerobics'; and online sports vision programmes. There is currently a paucity of research which compares different methods of vision training and, for this reason, to date there is no agreement over which types of visual skills training can be beneficial in athletics populations and if such training modalities provide significant improvements in visual abilities and on-pitch performance.

One method of improving vision which has perhaps been overlooked in terms of sports vision training is the use of video games which have been designed for pleasure as opposed to website-style programmes which are specifically designed for sports training.

Recent advancements in video games technology require the players to be exposed to a variety of visual stimuli and produce a physical response to them. Green, Bavelier, and colleagues have shown that there are many positive changes that can occur within the visual system as a consequence of playing video games such as improved visual attention, visual tracking spatial resolution selective attention and perceptual templates. Similar studies have also shown that video game players have shorter saccadic reaction times and a larger field of view than non-video game players. In terms of a direct link to improvements in sports performance, Frey and Ponserre found a positive transfer of video game playing to actual putting the skill in golf.

Due to the lack of studies comparing methods of vision training or examining the effects of video games on sports performance, this study compared three different methods of vision training and a control intervention in order to assess the effectiveness of visual skills and sports-specific skills training following a six-week intervention period in elite cricket players.

It was hypothesized that athletes undergoing visual training activities would show greater improvement on both visual and cricket tests than those undergoing a control intervention.

Material And Methods :

Participants :

Twenty-four professional male cricketers who were all playing at English county level (mean age of 24.38 ± 3.29 years) voluntarily participated in this experiment. All participants had normal or corrected to normal vision.

The participants were randomly assigned to one of four training groups: practical vision training (mean age 22.00 ±

1.79 years: two bowlers, two batsmen, one wicketkeeper and one all-rounder); computerised vision training (mean age 24.17 ± 1.94 years: one bowler, two batsmen, one wicketkeeper, two all-rounders); Wii vision training (mean age

27.83 ± 3.66 years: one bowler, three batsmen, one wicketkeeper, one all-rounder); and control (mean age, 23.5 ±

2.74 years: five bowlers, one batsman). All participants gave informed consent. Ethical approval was granted by the University of Surrey ethics committee and all procedures complied with British Psychological Society ethical guidelines.

Design :

Each participant underwent pre-testing on visual skills and cricketing skills. They then undertook six weeks of training specific to their randomly assigned group and were then post-tested on the same visual and cricket skills. Over the course of the six weeks, each player carried out their specified training for three half-hour sessions per week, giving a total of nine hours of visual training per person.

Training protocols – practical training :

The training methods for this group were designed according to the suggestions presented in popular sports vision text books [12-14]. Due to the nature and performance demands of cricket, the vision training drills included exercises aimed at improving focusing, eye speed and eye-body co-ordination. All these drills were piloted beforehand on a group of academy-level cricketers to ensure that they could be carried out in the time and space available and that the instructions were clear and easy to understand.

The practical group had four different exercises to work on in weeks 1 to 3. For weeks 4 to 6 they repeated the same exercises but with additional loadings to make the tasks more difficult. These are summarised in Table 1.

Table 1. Table 1: Practical group training exercises

Week	Exercise	Description	Training progressions for weeks 4–6
1 and 4	Reaction ball	Throw and catch a reaction ball against a wall as many times as possible in 1 minute. The distance to the wall was varied in each session, as was whether the ball was thrown over- or underarm	Use only one hand to throw and catch. Vary the hand used in each session
1 and 4	Juggling	Juggle with three balls for as long as possible	Try throwing the balls higher in the air. Try adding the fourth ball.
1 and 4	Pencil push ups	Hold a pencil at arm's length in front of eyes. Look closely at the end of the pencil, make sure the end can always be seen without double vision – if double vision is noticed, move it further away. See how close the pencil can be moved towards the face before vision goes double.	Move the pencil as close as possible and then 'jump' the eyes to look at something far in the distance. Then 'jump' the eyes back to the tip of the pencil and focus as quickly as possible
1 and 4	Focusing pursuits	A partner holds a small letter chart in front of the participant's eyes. They slowly move the chart around while	The same exercise but the participant stands on a balance board so they

		the participant calls out the letters. The participant must keep the letters in clear focus if they begin to blur the chart should be moved more slowly.	must maintain balance while keeping the letter chart in focus
2 and 5	Juggling and kick a football	Juggle with three balls while kicking a football against a wall.	Try throwing the balls higher in the air. Try adding a fourth juggling ball.
2 and 5	Number/ Letter trace	Number/letter charts were provided with the letters A–J and the numbers 1–10 written on randomly. The task was to time how long it takes to join up all the letters and numbers in order, alternating between numbers and letters. E.g. A – 1 – B – 2 – C – 3 etc. The pen must not be taken off the paper and a complete circle must be drawn around each	Number letter charts went up to T and 20.

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		number/ letter	
2 and 5	Brock string	One end of a brock string (which is a long piece of string with three beads placed along its length) is held to the end of the nose and the other is tied at a distance so the string can be held taut. The first bead should be focused on until the string appears to form a cross at the bead. Hold this gaze and then move the eyes to the second bead and fixate again. Repeat for all the beads several times.	The same but while standing on a balance board.
2 and 5	Carton catch	A 12-hole egg carton is used and each hole is numbered in order from 1–12. A coin is placed in hole one and the task is to flip the coin into all the holes in the correct order.	The holes are numbered in a random order instead of consecutively.

3 and 6	Peripheral catch	A fixation point is marked on the wall and eyes must focus on this at all times. Throw and catch a ball against the wall without moving eyes away from the fixation point	Same but while standing on a balance board.
3 and 6	Punching Os	A sheet of paper has a number of small letter Os printed on it in a random manner. The task is to put a pen dot inside each O as quickly as possible.	There are more Os on each sheet and they are smaller.
3 and 6	Balancing catch	The participant stands on a balance board while a partner throws a ball for them to catch. As confidence grows the ball should be thrown so it is more difficult to catch – either further away from the participant or thrown harder.	As partner throws the ball in they also call which hand has to be used to catch the ball.
3 and 6	Double brock string	Same as brock string above but with two strings tied to opposite corners of the room and the other ends of both held at the nose of the participant.	The same but while standing on a balance board.

Training protocols – online group training :

This training group utilized a bespoke internet based vision training software tool designed for the experimental condition. Each member of the online training group was given access to the programme. This programme consisted of six different drills, each of which had a total of 30 levels to work through. The athlete could only progress to the next level once they have reached a certain level of attainment at the lower level.

The exercises are summarised in Table 2.

Table 2: Online group training exercises.

Drill	Designed to test:	Task
Speed	The speed of eye movements	A series of arrows move at speed across the screen and the participant has to use the arrows on the keyboard to enter the direction that the arrows are pointing in the correct order.

PA	Peripheral awareness	A target shape flashes up on the screen for a short period of time with four other shapes surrounding it, one above, one below, one left and one right. One of the surrounding shapes matches the target shape and the participant has to identify the matching shape and press the arrow key which corresponds to its position around the target shape
Flex	The flexibility of eye in changing focus from near to far	In the bottom left of the screen, a target object will appear. Nine other very similar objects will appear on the screen and appear to move from near to far and vice versa. The participant has to identify which of the objects exactly matches the target and press the numerical key that identifies that object

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Track	Ability to track a moving object smoothly	A small green ball appears on the screen and can be moved around using the arrow keys. The participant's task is to move the green ball so that it stays within a larger grey area which is continually moving in an unpredictable manner. There are also small red balls that shoot across the screen and must be avoided.
Jumps	Ability to jump eyes quickly to a point of interest	Nine squares move around the screen in a random fashion. Each square has a number in it to identify it. At some point, one of the squares will flash red. The participant has to identify which square flashes and then quickly enter its number via the numeric key pad.
3D	Ability to use both eyes in combination to view 3D	A stereogram appears on the screen in which is hidden a sequence of numbers or letters. The participant must identify the sequence and enter it via the keyboard.

Training protocols – Wii group training :

This group had to play selected games on the Nintendo Wii video game console (Model RVL 001(EUR), Nintendo, Japan). Three different Nintendo Wii games were selected for the training in this study. The games were chosen because of the visual demands and physical responses to visual stimuli required in a short space of time.

Members of the Wii training group were given a different game to play for each of the first three weeks of training. Weeks four to six were a repeat of the first three weeks. The games that the athletes were told to train on are shown in Table 3.

Assessment protocols – cricket-specific assessment

Each player underwent seven different cricket skills-related tests. The tests were designed by the researcher and head cricket coach and then approved by the rest of the coaching staff who agreed that the chosen tests seemed to be valid measures of all-round cricketing skill. As these tests have not been used in previous research their reliability and validity are somewhat subjective but as they were designed by a vision coach and cricket coach they were considered the most suitable option. The tests are summarised in Table 6. All tests were scored on a scale of 0-2. A score of 0 meant that the player failed to adequately perform the required skill. A score of 1 meant that the player performed the skill adequately but not perfectly - for example, they hit the border of the target area or slightly fumbled a catch but did not drop it. A score of 2 meant that the player performed the skill perfectly. Prior to testing, participants underwent familiarisation on each of the tests in an attempt to avoid a learning effect. Scores were given independently by the researcher and two senior members of the coaching staff. Although the researcher knew which training group the participants were in, the coaches did not and were therefore blind in order to try and avoid bias in the scoring. After testing was complete the scores given were compared and all scorers had given the same marks to all players, therefore, giving 100% inter-tester reliability.

Table 3: Tests used to assess cricket skills

Cricket Test	Testing Method
Bat to cover	Bowling machine set at 80mph so that the ball reaches the batter at chest height outside off stump. The task is to hit the ball to 1m-wide area at cover
Bat to mid	Bowling machine set to 80mph delivering a straight ball. The task is to hit the ball to 1m-wide area straight down the wicket (between mid-off and mid-on).
Bat pull	Bowling machine set to 80mph to deliver a ball just outside off stump. The task is to pull the ball to a 1m-wide area towards backward square leg.
Bowl yorker	Bowling a ball to hit the middle stump. The ball must go underneath a hurdle placed on the line where the batsman would stand.
Diving Catch	Ball fed to either the left or right of a player and they have to make a diving catch.

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High catch	The ball is fed high into the air and the player has to move to underneath the ball and make a catch.

Throw to stumps	Player throws the ball from a distance of 20 meters to try and hit the stumps from a sideways angle so only one stump is clearly visible.

Table 4: Tests used to assess cricket skills

Cricket Test	Testing Method
Bat to cover	Bowling machine set at 80mph so that the ball reaches the batter at chest height outside off stump. The task is to hit the ball to 1m-wide area at cover
Bat to mid	Bowling machine set to 80mph delivering a straight ball. The task is to hit the ball to 1m-wide area straight down the wicket (between mid-off and mid-on).
Bat pull	Bowling machine set to 80mph to deliver a ball just outside off stump. The task is to pull the ball to a 1m-wide area towards backward square leg.
Bowl yorker	Bowling a ball to hit the middle stump. The ball must go underneath a hurdle placed on the line where the batsman would stand.
Diving Catch	Ball fed to either the left or right of a player and they have to make a diving catch.
High catch	The ball is fed high into the air and the player has to move to underneath the ball and make a catch.
Throw to stumps	Player throws the ball from a distance of 20 meters to try and hit the stumps from a sideways angle so only one stump is clearly visible.

Statistical procedures :

Data were collected from each participant across the 14 visual tests and seven cricket tests, both pre and post- the specific training programmes. Descriptive statistics were used to define the outcomes in each group. As several of the tests were scored on different scales the data for each test were first transformed into z scores so that direct comparisons could be made to explore the relative performance on each test across time.

Data were then analyzed using a three-way analysis of variance (three-way ANOVA) with training method (P, O, W,

C) as the between-subjects variable and time (pre- or post-) and test (14 visual and 7 cricket tests) as the within- subjects variables. All main effects and interactions were tested other than the main effect of test, which due to the standardization process (use of z scores) is not meaningful. Statistically significant findings were then investigated further using Tukey HSD post hoc tests.

Prior to the ANOVA, homogeneity of variance was tested and the data were found to violate the assumption of sphericity. Therefore the Greenhouse-Geisser correction was applied. Alpha was set at $p<.05$ level.

Results :

The results of the three-way ANOVA found a significant main effect for time, F (1,20) = 79.60; $p<.001$; partial $\eta^2 = 0.80$; observed power = 1.0.

There was also a significant interaction effect between time and treatment group, F (3,20) = 4.99; $p<.01$; partial $\eta^2 = 0.43$; observed power = 0.85.

Tukey post hoc analysis on this interaction showed that all experimental groups significantly improved from pre- to post-test, whereas the C group showed no significant improvement (P, $p<.001$; O, $p<.01$; W, $p<.005$; C $p=.67$).

However, no significant differences were shown between any of the different training groups (see Figure 1). No main effect was found for group, F (3,20) = 0.355; $p=.786$; partial $\eta^2 = 0.051$; observed power = 0.107.

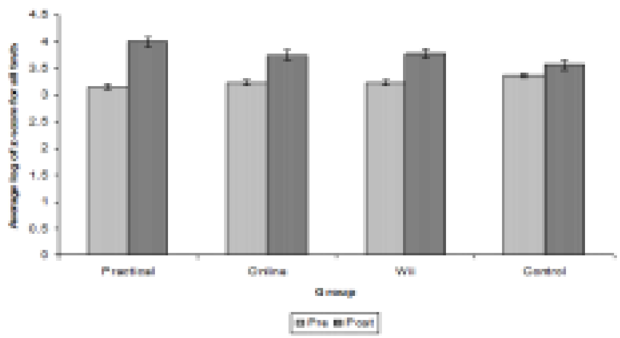

Figure 1: Interaction between time and treatment group (* signifies significant improvement)

A significant interaction was found between time and test, F (20,400) = 1.721; $p<.05$; partial $\eta^2 = 0.08$; observed power = 0.97. Raw data can be seen in Table 7.

Table 5: Raw scores on each test at pre-test and post-test averaged across all participants. A ^ indicates that a low score on this test signifies better performance.

Test	Pre-test score	Post-test score
Howard Dolman Test ^	31.17	21.83
Rotator board	10.42	13.29
Horizontal saccades	55.38	64.91
Focus flexibility	61.71	68.29

Crazy Catch	44.67	50.71
Crucifix Ball Drop	9.63	13.13
Visual Memory	3.19	3.83
Wayne 9.1	37.38	45.58
Wayne 9.11	27.71	29.08
Wayne 9.21	2575.75	3285.38
Wayne 9.62	41.63	45.21
Remote Control Car Test ^	127.79	92.29
Bassin Anticipation Timer ^	0.219	0.190
Flippers	24.67	28.21
Bat to cover	6.92	8.25
Bat to mid	5.63	7.54
Bat pull	8.67	8.38
Bowl yorker	2.71	3.92
Diving Catch	7.83	8.54
High catch	8.58	9.58
Throw to stumps	3.96	6.75

Tukey post hoc analysis showed that performance on all tests improved from pre- to post-test with the exception of bat pull. When the more stringent Bonferroni post hoc test was used eight of the 21 tests still showed a significant pre- to post-test improvement. These were rotator board ($p<.005$), crazy catch ($p<.001$), Wayne 9.1 ($p<.001$), Wayne 9.21 ($p<.005$), crucifix ($p<.05$), horizontal saccades ($p<.01$), bat to mid ($p<.05$), and throw to stumps ($p<.001$). A significant three-way interaction between test, time and group was also found, $F(60,400) = 1.547$; $p<.01$; partial $\eta^2 = 0.19$; observed power = 1.

Discussion :

The original hypothesis which proposed that the three experimental groups would perform better than the control group was proved correct. All three experimental groups improved significantly from pre- to post-test whereas the C group showed no significant improvement. This shows that any of the three forms of vision training used in this study were able to improve some aspects of both visual and cricket skills more than just training on cricket skills alone. This improvement in visual skills supports previous studies, which showed that basic visual skills can be improved through many repetitions of training. Although there were no significant differences between the improvements shown for the three experimental groups, Fig 1 does show that the two computers based groups (W and O) improved a similar amount with the P group showing the greatest level of improvement. The fact that some of the basic cricket skills also improved significantly in the experimental groups supports the suggestion of Wilson and Falkel that improvements in visual skills will carry over and create improvements in performance on the field of play.

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