

Visual performance in cricket

As England's cricketers take on the West Indies pace men, Richard Morwood and Geraint Griffiths explain why the performance of cricketers can be improved by testing and correcting vision. Much of the material is based on a study of the Scottish cricket team



Cricketers at all levels could benefit from thorough testing of vision

It is likely that visual performance plays a greater part in cricket than in non-ball sports and that visual ability could have some bearing on results. It is also interesting, in the light of Australia's current predominance in world cricket, that sports vision science in that country is well advanced; it now has the first accredited sports vision course in the world.

The UK also now has an accredited sports vision course at Umist, reflecting a growing interest in this aspect of optometry. In parallel with this initiative the Sports Vision Association has been collecting data from many of our leading athletes. This report is based on the visual assessment of the Scottish cricket team last year (selected results, Tables 1-3).

Demographics

At the outset of the screening, the 15 players completed a questionnaire (Table 1). All but one of the players rated their vision very important, but up to half of the players had not had a recent eye examination.

This suggests that those players assumed there was no deficiency in their visual performance. The players were quite willing to talk about their visual performance and over half of the group (53 per cent) had problems in the context of elite sporting performance, which may be solvable.

The basic measurement

Static, high and low-contrast vision

This is the basic measure of visual performance and the most amenable to correction and improvement. It was measured as the athletes presented, corrected as they would normally play. Deficits can make it difficult to see small objects. An imbalance between the eyes can affect depth perception and anticipation (the earlier the ball is seen the better the anticipation, so the player remains calm and controlled).

Here, only 30 per cent of eyes had 6/6 or worse, indicating a better than average visual performance. Where there are small focusing errors in one eye, these are likely to be exaggerated in low-contrast conditions and affect the performance of the two eyes together.

Table 1**Demographics (after Loran)**

Total screened: 15

Average age: 28 (range 18-41)

Average years playing professionally : 9 (range 1-21)

Combined international experience : 301 caps

		Number	%
Playing positions	Bat. (incl two keepers)	5	33.3
Head injuries	Bowl	4	26.7
(26.7% of players)	Wicket keeper	(2)	(13.3)
	All round, bat and bowl	6	
	Bat, (incl two keepers)	1	25
	Bowl	1	25
	Wicket keeper	0	0
	All round, bat and bowl	2	50
Eye injuries	Bat, (incl two keepers)	0	0
(15% of players)	Bowl	2	66.7
	Wicket keeper	0	0
	All round, bat and bowl	1	33.3
Previous exam	Optometrist	9	60
	Doctor	1	6.7
	None	4	33.3
Wearing a visual correction	Glasses	4	28.6
(26.7% of players)	Contact lenses	2	14.2
Players reporting visual difficulties		5	33.3
Utilise visualisation		12	80
Importance of vision	(Very important)	15	100
Further examinations recommended		9	60

Muscle physiology

The first main area of consideration measures physiological characteristics of the eye and the eye/body relationship.

Dynamic fixation

This is the ability to move the eyes rapidly from one position of gaze to another (Figure 1). The way in which eyes move may reflect the skills required by a specific activity.¹ Deficits can affect concentration. The average time for dynamic fixation shows that cricket has an average of 17.78 seconds, compared with archery, 18.20, and track athletics, 15.81. This suggests that control and timing are the most important aspects of cricket.



Figure 1 Test for dynamic fixation

The suggestion that muscle performance is innate (the striated extraocular muscles are basically the same type as all the other skeletal muscles) and that cricket players have a certain type, has been made in earlier research.¹

Within this performance characteristic muscle performance in the eyes and other skeletal muscles can be further affected by hydration. A fluid loss of only 2 per cent of body weight can reduce muscular efficiency by up to 20 per cent. In a less energetic sport like archery, between 1 and 2.5 litres are lost per hour, so in cricket, especially bowling, it is likely to be higher. Players should keep their fluid levels up at all times.

Eye muscles and the retina are also sensitive to the concentration of metabolites oxygen and sugar, in the blood stream. Hypoxia is minimised by general fitness training, but blood sugar levels need to be maintained; if not, the player may complain of blurred vision and loss of control of the external eye muscles could give diplopia.²

Muscle balance

A basic measure of muscle balance is made with the Maddox wing, but most of the of the tests depend to some extent on good co-ordination between the eyes; vergence facility, dynamic fixation, Mallet test, cover test, stereo test (Table 3). If there is a deficiency each of the tests will provide a different clue as to the cause and suggest a possible course of treatment. At worst, problems could cause double vision, but headaches, loss of acuity and visual fatigue during a hard game are more common.

The most likely benefit of eye exercises is an improvement in the performance of the extraocular muscles and muscle balance.

The Brock string (bead on a string exercise³) is useful because it can show directly when a player is having difficulty locating the eyes on an object. By positioning the beads appropriately the test can be made specific to the event;

in exophoria the eyes focus beyond the ball (or the bead) so a stroke may be played late.

In esophoria the eyes are focused in front of the ball so the hit or the catch will be made too early, the ball is judged to arrive before it has.

Muscle balance anomalies to which the player is well adapted need to be differentiated from others which could affect performance.

Hand/eye co-ordination and response time

This is the co-ordination of the eyes, hands and body as a unit. Deficits can affect levels of performance in eye-led sports like cricket, boxing and tennis, by slowing the athlete's action and reaction times. In cricket, a measure of the hand/eye response time is particularly helpful and can be affected by the quality of the visual image. The average hand/eye response time (proaction) for this group was 0.61 seconds, measured on the Wayne Saccadic Fixator (Figure 2) which is also used with the balance board.

In proaction mode, the lights remain on until they are hit. This simulates an action initiated by a player such as throwing a ball.

In reaction the lights are switched off after a fixed interval if they are not hit, so there is an added incentive to reach the light before it goes out.

This equates to the time to respond to a visual stimulus and involves the ability of the athlete to use sound to assist any visual stimulation, typically in the slips. Deficits will slow overall response times.

Peripheral awareness



Figure 3 Peripheral awareness test

This is the ability to be aware of peripheral objects while maintaining central vision; it avoids having to concentrate too hard on straight ahead. Deficits can cause athletes to lose objects to the sides of where they are looking, or be distracted by them. Peripheral awareness is shown in Figure 3.

Cricket requires testing good peripheral awareness, but there is a danger that concentration on catching a ball will reduce it, when two or three players may be running for the same catch. Here, peripheral awareness in the group was very good. The average response time on the third trial was 0.67 seconds which compares with the average hand/eye reaction time of 0.60 seconds.

Eye dominance

In ball sports, strong eye dominance is important because a reference eye is needed to judge, aim and position. Confused dominance causes problems in archery for example,⁴ which is another control sport.¹

Where there is weak dominance, visual performance needs to be carefully measured to make sure that the potentially dominant eye is not compromised by an imbalance between the eyes or poor visual correction, or in batting, by a poor head position.⁴

Left eye dominance which often goes with left handedness is likely to be low in the general population, but in this group 50 per cent of the players are right eye dominant and 50 per cent left eye dominant.

Also less common is cross dominance (left eye, right hand) but in this group almost half are cross dominant. In general terms the figures are quite unusual and might indicate visual characteristics which are an advantage in cricket.

Although half the total group is cross dominant, which is already unusual, four out of five of the specialist batsmen are totally right dominant (right eye, right hand). It was expected that in batting right-handed, it would be an advantage for the leading left eye to be dominant, as studies have found with successful baseball teams in the US. However, there are differences between the games which may be significant

Critical movement of the ball in baseball is up and down, because the bat is held horizontally. In cricket it is side to side, the bat being held vertically to reduce errors in vertical judgement. Hitting rate is also higher in cricket.

It may be that horizontal movement is easier to judge than vertical movement with stereoscopic vision and two eyes. If the specialist batsmen are totally right dominant, then, in order to take advantage of good stereoscopic vision, the head should be facing forward.

For the less experienced batsman with a less than full head turn, cross-dominance is an advantage because at least the reference eye is leading. The innate disadvantage of being left-eye dominant is that it predisposes to left handedness, which may reduce reaction times and physical strength as shown by measurements in soccer.⁴

For bowling in the conventional way, a sideways delivery with the dominant eye peeping over leading arm, cross-dominance is again an advantage, especially if it is left eye, right hand. This allows the naturally strong right side to deliver the ball.



Figure 2
Wayne Saccadic Fixator balance board

Eye/foot response time

This test measures how well the limbs are co-ordinated using the balance board extension to the Wayne Saccadic Fixator (Figure 2). The average score for this group was 37 hits in 30 seconds. This compares with 41 for Leyton Orient Football Club.⁴

Effects of light in the sporting situation

Another area of consideration is the visual demand made on the eyes in the sporting situation, this takes the effect of light and movement more into account.

Colour vision

Colour deficiency affects 8 per cent of the males on average and can make it difficult for athletes to follow moving objects. In this study, there were no colour defects. In cricket, colour vision is likely to be less critical than in, say, soccer, where recognition of strip colour in poor lighting or after a fleeting glance is very important

Contrast sensitivity

This is the ability to see an object against its background, which is more difficult when the lighting is poor and colours are similar. Deficits make it difficult to see and follow objects. Corrections of small amounts of myopia in one or both eyes as well as proper maintenance of contact lenses will optimise contrast sensitivity.

The results were generally very good with only three players scoring below 5 on the CVS1000 tester (Figure 4). Where the reading is low, the measure of high- and low-contrast static vision in each eye will give a clue to the cause.



Figure 4 Vector Vision CVS 1000
contrast sensitivity test

Glare recovery

This is where comfort and visual performance are reduced by a relatively bright light source in the visual field. Recovery to a 6/12 line of letters was timed after the flash from an ordinary camera flash bulb held at 2/3 metre. In situations of glare there is loss of vision and this varies considerably from one individual to another.

Maximum time was 17 seconds and the minimum of 5 seconds in players without sunglasses. The eyes should be protected before and after the match, during training and even during the match with UV-blocking contact lenses, particularly in players shown to be susceptible.⁴

Recovery from glare was shown to be quicker in both light and dark coloured eyes with the sunglasses than without. The proportion of dark eyes to light was about 50:50.

The results do show, however, that there can be a considerable time delay after the flash from the sun or a floodlight before the eyes can see again, let alone make the fine judgements required in hitting and catching.

Although there were insufficient numbers to determine a statistical significance, the results on average showed that without a visor, the dark eyes (11.33 seconds) recovered more slowly from the effect of the flash (blue eyes 8.17 seconds). In general, dark eyes are better protected against the sun but it is possible that if they are surprised by a flash of light when the pupil is wide, that the usually better protected and more sensitive retina takes longer to recover. It follows from this that the blue eye is continually coping with more light than the brown eye.

Poorly placed floodlights as well as solar radiation can cause glare problems. Prolonged exposure to ultraviolet radiation in sunlight might lead to cataract formation and macular degeneration in later life,⁵ especially in fair-skinned, blue-eyed people who have less natural pigment in the iris and on the retina. Infra-red radiation (heat) will tend to dry the cornea and diminish its optical properties (sharpness of vision and depth perception). Consequently, sports people should be encouraged to wear sun protection.

Visualisation

This is the ability to imagine and mentally rehearse sporting actions and responses. Deficits can hinder the best response in the game situation and make it difficult for the athlete to learn from mistakes.

Basin anticipation timer

This instrument measures how well subjects can time the arrival of an object traveling towards them at speeds of 5,10 and 15mph. Negative results show a late response and positive an early response.

These relatively low speeds (compared with the speed with which the ball is bowled) were used because the apparent speed of the ball moving straight to the batsman is governed by the rate at which it is falling vertically or swerving horizontally. The components of the speed in these directions is much slower than the actual speed of the ball towards the bat. The forward movement of the bat may be a simple reaction to the release of the ball from the bowler's hand, but sideways and vertical movement in flight can, up to a point, be followed.

This is arguably one of the most important tests for cricket and shows quite a wide variation of results. Some of the weaker measurements do seem to be associated with vergence and accommodation problems which could make the possibility of boosting control with eye exercises significant. Consistently late responses could indicate a problem with convergence, for example.

It is interesting to see that the best performances were at the low and high speeds. The two lower speeds probably give a real reading of timing ability, which is harder for the faster speed. Once the speed goes over 10mph the test becomes a reaction to the first light in the sequence, rather than following the sequence of lights to the end.

Conclusions

Zone of fog

Each player has a zone of fog where they are unable to react quickly enough to, say, a bouncer, or a slip catch. The findings for hand/eye response time and peripheral awareness have important implications in cricket, related to the speed of the ball and the length of the pitch.

In first-class cricket the ball is likely to be delivered by a fast bowler at speeds of up to 90 mph⁶. If the pitch is 22 yards long, it takes 0.5 seconds for the ball to travel from one end to the other. For a response time of 0.4 seconds, there will be a zone of fog of 25 feet in front of the batsman where he will not be able to respond to any unexpected change of direction of the ball.

This zone of fog emphasises the importance of anticipation; anticipation of the swing of the ball in the air and of the direction of delivery. This in turn relies on following the bowler's hand up to the point of release and the ball for as long as possible, as it approaches the bat. It is clear that anticipation time will therefore be affected by the various visual skills, all of which are amenable to correction and therapy (Table 2).

Table 2 Visual skills and their application in cricket	
Visual skill	Application
Eye movements; pursuit, saccade, vergence and motility Visual acuity Contrast sensitivity Hand/eye response time Accommodation facility Glare recovery	Pursuit of the bowlers hand and following the ball Bowlers hand grip Bowler's hand against the background Reaction to speed and direction of the ball Speed of changing focus Dealing with different levels of illumination

Visual strategy

What is important for batsmen to realise is, that given the limitations of the visual system, there will always be some deliveries about which they can do nothing. Any batsmen who has faced Curtley Ambrose will surely confirm this!

There is no advantage then in allowing the body to tense up in nervous anticipation. This is equivalent to 'white knuckle syndrome,' which afflicts some motorists. The features of this are hands clamped to the steering wheel and the nose is pressed against the windscreen as the motorist tries to prepare for a juggernaut unexpectedly looming out of the fog. In this physical state, muscle groups tense against one another, slowing reaction time.

So for cricketers, as for drivers, the advice must be that relaxation, the maximisation of visual performance and concentration can significantly improve standards.

Table3

**Sports vision profile (after DFC Loran)
Scottish cricket squad**

			May need attention	Below AV	Av	Above Av	Excellent	SD
Vision	90 %	R	0.24	0.1	-0.04	-0.18	-0.32	0.14
		L	0.19	0.07	-0.05	-0.17	-0.29	0.12
	10 %	R	0.64	0.45	0.26	0.07	-0.12	0.19
		L	0.54	0.38	0.22	0.06	-0.1	0.16
Vernier acuity			2.17	3.44	4.71	5.98	7.25	1.27
Vergence (cycls /mm)			13.03	18.23	23.43	28.63	33.83	5.2
Focus (cycls/min)			5.04	12.59	20.14	27.69	35.24	7.55
Dynamic fixation (secs)			24.74	21.26	17.78	14.31	0.82	3.48
Dynamic acuity			67.98	77.05	86.12	95.19	104.26	9.07
Contrast sensitivity			3.79	4.75	5.71	6.67	7.63	0.96
Graded 1-8)								
Peripheral awareness (secs)			0.93	0.8	0.67	0.54	0.41	0.13
Hand/eye co-ordination (score in 30								
Proaction			39.24	44.37	49.5	54.63	59.76	5.13
Reaction			31.21	34	36.79	39.58	42.37	2.79
Eye/foot response time (score in 30 secs)			27.81	32.65	37.49	42.33	47.17	4.84
Glare recover (secs)	with visor		13.27	10.06	6.85	3.64	0.43	3.21
	without visor		17.08	13.15	9.22	5.29	1.36	3.93
Stereopsis	minutes of arc		147.46	103.73	60	16.27	(-27.46)	43.73
	Time (secs)		10.97	7.76	4.55	1.34	(-1.87)	3.21
Anticipation (seconds x 100)			15.35		7.06	.2.92	(-1.22)	4.14
			May need attention		Av		May need attention	SD
Muscle balance Δ (minus = exo)								
		Near cover	-3.87	-2.22	-0.57	1.08	2.73	1.65
		Wing	-5.71	-3.86	-2.21	-0.36	1.49	1.85
		Brock string	-2.48	-1.82	-0.17	0.49	1.15	0.66

Acknowledgments

I would like to thank the following for their valuable contributions to this research: Jim Love Geoffrey Balantine, Linda Bennett, Dr Ian Cockerill, Don Loran and Peter Smith at the Sports Vision Association for permission to publish.

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