

Eye dominance in sport

A comparative study

Perhaps the most important contribution sports vision could make, is to demonstrate a direct relationship between vision and sporting performance. Scientific proof, if it exists, could have a profound effect on thinking in optometry, the sporting institutions and amongst coaches and sports participants (50% of the population¹). It may also have implications in other areas of occupational optometry.

The phenomenon of eye dominance is well established² and seems to parallel the asymmetry of the brain, which is broadly divided into left and right hemispheres having different and complementary functions³.

During the years of its development, the Sport Vision Association (SVA) has collected data from over 17 elite groups of athletes including international and national teams and one of the many interesting patterns which has emerged is in eye dominance.

It might have been expected for the pattern to follow the general population that is predominantly right eyed and right-handed² but this is not the case. The data also confirm that eye dominance is not an infallible predictor of hand dominance (Table 1). In archery, up to 80% of athletes are right-handed and right eye dominant (right ipsi lateral). In cricket, only 50% of the players are right dominant, the other 50% are cross dominant (right or left contra lateral). This may be because bowlers lead with their left eye and specialist batsmen aim with their right⁴. In yachting (British Olympic Team, Atlanta) the majority is left eye dominant (57% N = 14). Eye dominance appears to be important whether it is learned or innate and may predispose to particular sports.

Binocular vision

One of the problems of binocular vision is that although there are two eyes, there is usually only one object of interest. The distance between the eyes is small, but it still means that the object of regard will appear to be in slightly different places if

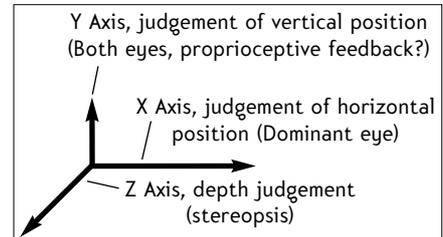
looked at by each eye individually. It is the disparity between the images (which decreases with distance) which gives us our ability to perceive depth. This ability is not innate and unless binocular vision is established early in life, stereopsis cannot develop⁵. But it is not enough to know how far away an object is. When a player in the outfield runs to catch a ball in cricket, the timing in which stereopsis plays an important role, depends on the distance and speed of approach of the ball. To catch the ball, the cupped hands have to be aimed by lining up with the ball and the eye and for that, one eye needs to dominate. It could be suggested that judgement of position in space requires, a different mechanism for each dimension (Figure 1).

Case study

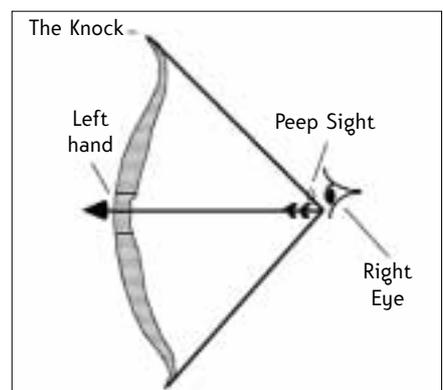
The importance of the aiming and the dominant eye is illustrated in archery. A national coach, who is also a club level archer, was concerned by a loss of form which threatened to undermine her confidence at a time when she was training well and more in touch with her sport than ever.

Top class archers are not concerned with the target in general, their aim is the centre (the gold) and her shooting had been affected in a curious way. The grouping of her arrows formed a horizontal line to the left of the gold (bull), vertical judgement was excellent but her aim was drifting to the left.

The effect of the dominant eye in archery is very important. Ideally, right-handed archers should have a right dominant eye. When the bow is drawn



» Figure 1 Judgement of position in space



» Figure 2 Bow position

back, the peep sight in the string lines up with the right aiming eye (Figure 2).

Strongly right dominant athletes can shoot without closing their left eye, because the brain is able to ignore what it sees. It is always better to keep both eyes open because this maximises acuity⁶, contrast sensitivity⁷, depth judgement and peripheral awareness, and stops the muscles around the eyes from getting tired. If the left eye is dominant in a right-handed archer, it often has to be occluded to stop it taking over.

This archer's right dominant eye was slightly short-sighted. With her vision of the target already slightly blurred, when the string partially covered her right eye as she aimed, it reduced her view so much that the left eye took over. During the aiming process, this happened sub-consciously – her brain did not know which eye was providing the information, just that this was the best available. Unfortunately, the left eye was not in line with the peep sight and the arrows were shot to the left of the gold. The problem was corrected with a minus 0.75 soft contact lens in her right eye.

For well-understood and fairly self-evident reasons, a contact lens is the correction of choice in sport often in combination with prescription and plano appliances (Table 2). The exception is the aiming sports where shooting specs are preferable.

» Table 1 Incidence of eye dominance in elite sport (%)

Dominance		Cricket	Archery		Football	Rifle
Eye	Hand	Scottish National N = 15	Internationals N = 16	Coaches N = 70	Leyton Orient N = 18	GB Junior Squad N = 32
Right	Right	46.7	62.5	84.3	55.5	87.5
Left	Left	6.6	18.75	10	11	3.1
Right	Left	6.6	6.25	2.85	16.7	0
Left	Right	40	12.5	2.85	16.7	9.4
%Cross Dom		46.6	18.75	5.70	33.3	9.4

» **Table 2** Advantages of contact lenses in sport

Optometric	Dispensing
- No differential prismatic effect in different positions of gaze	- Tinted lenses to control UV and visible glare
- Correction of astigmatism and other eye aberrations	- Protection from non-ionising radiation
- Correction of muscle balance problems, vertical and due to the prescription (eg decompensated esophoria related to hyperopia, affecting depth judgement and timing)	- Do not steam up
- Correction of monocular problems which affect depth perception	- Reduced risk of facial trauma due to lens fragments or frame edges
- Correction of small amounts of astigmatism with aspherics or GP lenses to improve contrast sensitivity	- No disturbing movement when jogging
- Correction of low levels of myopia down to -0.25 (equivalent to -0.75 under correction based on the modal value for athletic groups ⁹), which can be highly symptomatic	- No problems with poor fit or frame slipping
- Correction of hyperopia in young athletes leading to decompensated esophoria	- Cosmesis
- Lens looks where the eye looks	- Full wrap protection from plano sunglasses over contact lenses
	- Increased peripheral awareness, wider field of view. No blind areas in field and by frame.
	- Reduced magnification effect
	- Reduced spatial distortion
	- Good vision in the rain

» **Table 3** Measures of visual performance in sport and associated procedures

Measure	Associated procedures
High and low contrast logMAR vision	Refraction
Contrast sensitivity	Binocular balance
Depth perception	Muscle balance
Accommodation	Dynamic fixation ¹²
Vergence	Orthoptics, vision therapy ⁵
Stereopsis	Light sensitivity and colour preference, glare recovery ^{13,14}
Light adaptation	Dispensing (e.g. contact lenses)
Hand-eye co-ordination	Nutrition ^{15,16}
Peripheral awareness	Hydration
Dynamic vision	
Anticipation timing	
Visualisation	
Endurance	

» **Table 4** Levels of logMAR vision, their Snellen and Bangerter equivalent

LogMAR	-0.2	-0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Snellen	6/3.8	6/4.8	6/6	6/7.5	6/9.5	6/12	6/15	6/19	6/24	6/30	6/38
Bangerter	N/A	N/A	1	0.8	0.6	0.5	0.4	0.3		0.2	

» **Table 5** Incidence of dominance

Eye	Hand	Tennis % (N = 14)	Clay Shooting % (N = 13)
Right	Right	57.1	46.1
Left	Left	0	7.6
Right	Left	28.6	15.4
Left	Right	14.3	30.8
%Cross Dom		42.8	46.1

Binocular balance

This case study and previous research^{9,10} suggest that the visual system is sensitive to disruptions of the normal relationship between the eyes. This may provide the basis for a more sensitive measure of visual performance which, unlike previous research¹¹, could demonstrate formally the relationship between vision and sporting performance.

For instance, if it could be shown in groups of established athletes that a disruption of binocularity affects a critical part of their playing skill, it would make a

case for optimising other aspects of visual performance (Table 3).

Occlusion

The way in which binocular vision is disrupted is pivotal. Simply occluding one eye would be too gross a disruption and would not simulate the sort of effect which occurs naturally (increasing myopia, the effect of age on accommodation, previously uncorrected astigmatism, the effect of small prescriptions) of which the patient is unaware, especially if it is monocular. Blurring the vision with a spectacle lens (plus, minus or astigmatic) would have a variable effect, depending on the subject's own refraction. A plus 1.00 lens, for instance, would have no effect on a plus 1.00 hyperope. Making spectacles individually would be impractical, even if internationally-based groups could be co-ordinated. Using contact lenses would be even more problematic with the additional requirement of physiological compatibility.

Bangerter Foil¹⁷

A method was required which produced a measurable amount of blur in subjects whose vision, as they competed (with or without a correction), was within a defined limit of say 6/6 or better in both eyes.

Bangerter Foil is a similar plastic material to the licence holder on the inside of a car windscreen and sticks without glue to a smooth optical surface. A process similar to the way prism is applied to a Fresnel lens achieves the required degradation of transmission, by means of a microscopic pattern uniform over the surface. The transmission is graded from 0.0 LP < 0.1, ~0.1, ~0.2...~0.6, ~0.8, to ~ 1.00. Each grade roughly corresponds to the decimal Snellen equivalent of its level of logMAR vision (Table 4).

Hypothesis

Based on the experience in archery, it was proposed that the occlusion of the dominant eye in aiming sports would have a disproportionate effect compared with any reduction in binocular Snellen acuity on the ability to hit the target. Aiming is not restricted to the target sports. Catching a ball in cricket was discussed earlier. In football, the ball is kicked by lining up the foot, the aiming eye and the goal. In fencing, similarly the tip of the foil and a target on the body of the opponent. Other sports could also be considered like netball, water polo and hockey.

Subjects

To test this hypothesis, a group of international tennis players and a group of club clay pigeon shooters, each with an average age of around 43, were compared in June, 2002. Just under half (~43%) of each group used spectacles for distance or

near but 50% of the tennis players and 84.6% of the clay shooters had visual difficulties. The average logMAR vision (as they played) was R -0.06, L -0.11 for the tennis players and R -0.117, L -0.102 for the shooters. The incidence of eye dominance is shown in Table 5.

Tennis – the Marsh Classic at the Hurlingham Club Fulham (18/02/02). Fourteen players on the masters' circuit including winners and finalists at Wimbledon, the Australian, French and US Open championships.

Clay pigeon shooting – Braintree Clay Pigeon shooting club (22/06/02). Thirteen club shooters were assessed.

Procedure

Both groups were asked to fill in a general questionnaire before being assessed by a battery of diagnostic tests including:

- High and low contrast logMAR vision as the athlete plays
- Eye dominance
- Retinoscopy
- Muscle balance (Howell phoria)
- Compensation (Brock string)
- Colour preference (to quantify the need for sporting tints)

Measurement of dominant eye

The dominant eye was measured by asking the subject to hold their hands in front of them and place the right hand over the left, leaving a small gap formed by the apexes of the index finger and thumb. Then the arms were extended until the nose of the assessor was visible through the gap (Photo 1). The measurement was repeated with the left hand over the right and twice more; right over left and left over right. The observer records the eye which can be seen through the gap. For strong right dominance, the result would be recorded 'RRRR'. Weak right dominance might be recorded 'RLRR'. Equal dominance would be recorded 'RLRL', the dominance changing with the position of the hands. If strong right dominance is the norm, any deviation could be considered a left tendency.

The particular advantages of this method are the symmetry of looking at the

observer's nose rather than one eye or the other, and repetitions using one hand then the other on top. This helps to prevent a left or right bias. The method always produces a result even though there may occasionally be hesitation (which is significant and should be recorded). Methods which produce a result of no dominance (equivalent in this test of the hole being lined up equidistant between the subject's eyes) would not have been useful in this research and may be measuring dominance at a higher level.

Introduction

An introduction to sports vision is usually given before any screening exercise to explain the tests and why they are being done. This always increases the co-operation of the athletes and helps to take the fear out of the situation, where athletes feel that a poor result will affect their team selection. On this occasion, it was not possible to give a presentation to the tennis players because their programme was too varied and full.

Occlusion

Using grade 0.3 Bangerter Foils, which reduced vision to about 6/15, three pairs of sport goggles were prepared (Figure 3 and Photo 2). Pair A was the control with no foil attached; B foil was attached to the right oculus; and C to the left.

Experimental procedure – tennis

The tennis players each received volleyed balls delivered from a machine called a Lob-ster (Photo 3) which had a fixed speed of delivery and was angled so that the players received the balls at about waist height, half the length of the court from the delivery machine. Wearing each pair of goggles in turn, they then had to direct 10 deliveries (30 altogether) on to an archery target placed at 90° to the direction of the ball at about 3m (Photo 4). All the players were right-handed, so this meant that they had to play a forehand shot to their left to hit the target. The target was divided into three scoring areas, the centre scoring three and a complete miss – scoring zero.

Figure 3 Partial occlusion of the sports goggles

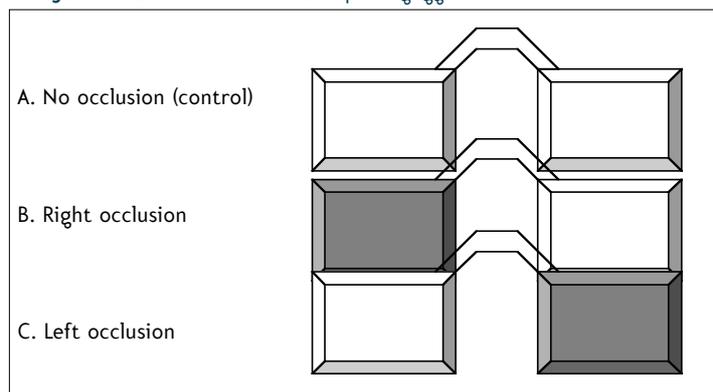


Photo 1
Measuring the dominant eye



Photo 2
Sports goggles (by courtesy of Inland)



Photo 3
The Lob-ster



Photo 4
Archery target with markings

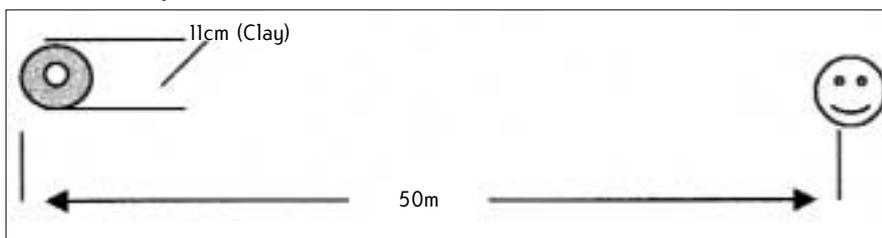
Experimental procedure – clay pigeon shooting

The shooters also had 10 trials in each pair of goggles. Their target was a clay pigeon launched straight towards them from a distance of about 70 yards. A hit scored one and a miss scored zero. All shooters were asked to keep both eyes open, even if they normally shut their left eye at some point in the execution of a shot.

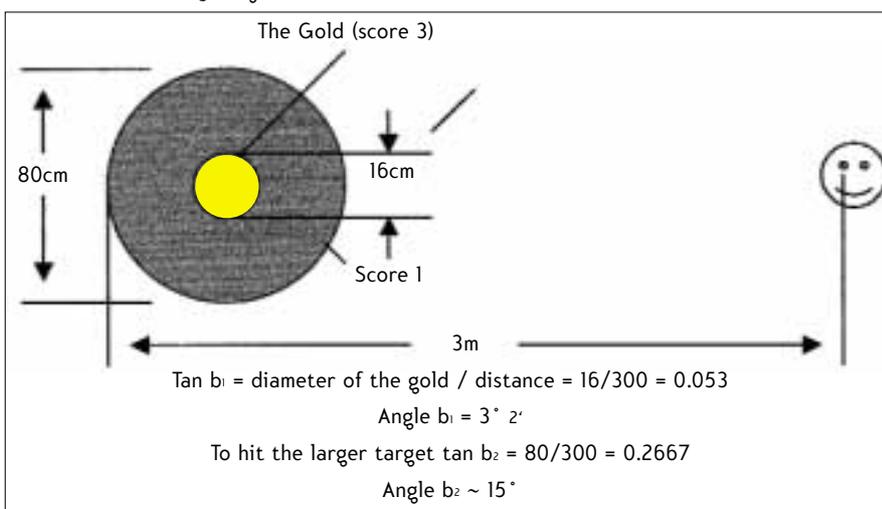
Figure 4

Relative target sizes in clay shooting (a) and tennis, the archery target (b) and on the tennis court (c)

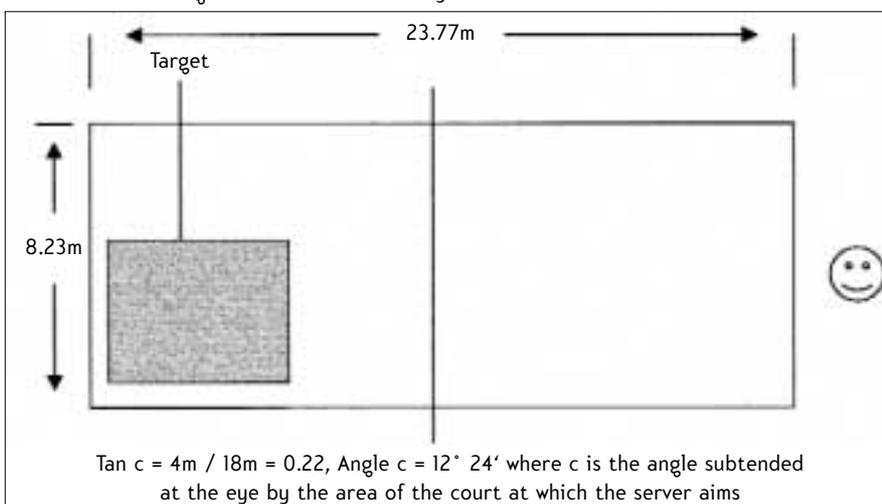
(a) Clay shooting (not to scale)



(b) Tennis (an archery target)



(c) Tennis court (target size for the server say)



Target size

A consideration of the skills in an individual sport needs to take into account the target size.

In terms of angular subtense, the centre (gold) of the archery target is 23x the size of the clay in clay pigeon shooting. Taken as a whole, the archery target is 112x the size of the clay pigeon shooting. The tennis target is roughly 23x the size of the clay (worked out from target size and distance). To put target size into perspective, the target area on a tennis court where the server aims is about 90x the clay size (Figure 4).

Double masking

A degree of masking was built in to increase the validity of the results. Those researchers doing the main experiment were not part of the screening team and were unaware of the eye dominance of the players and shooters.

The players themselves may have been aware which eye was dominant, but not the effect that was hypothesised. The effect of learning was to some extent countered by using the control goggles first, so that subsequent results, if worse, could not be attributed to learning the task.

Results

From the demographics, it is clear that the incidence of eye dominance in these groups does not conform to the expected norms. Perhaps this is more surprising in the clay shooters whose sport is apparently similar to rifle shooting.

Analysis

To test probabilities, the scores for each attempt, 1 – 10, were totalled. A one tailed, paired t-test was applied to the various groups being compared, such as no occlusion vs. right occlusion.

Probability

The t-test returns the probability (p) that the two sets of data (samples) come from the same population that is there is no difference between them. For p to be significant, it must be less than 0.05 (a 5% probability)

Normal distribution

One of the conditions of the t-test is that the data fits a normal distribution. It was apparent that the first shot in tennis was very low scoring and that at least one delivery was required to learn how to receive the ball and hit the target. This was an unusual task for the tennis players, playing a shot that is not usually part of their game. To allow for the learning curve, the first two shots of the tennis players' results were ignored, assuming that the remaining shots followed a normal distribution.

The clay shooters' were given an easy target (a clay fired towards them from a straight ahead position), to reduce unwanted variables. It was assumed that all 10 shots would follow a normal distribution.

Shooting

A summary of scores and associated dominance is shown in Table 6, each score being made of 10 trials with a maximum possible score of 10.

The pattern of scoring between strongly right dominant shooters (arranged in the top half of Table 6) and those shooters who had a left tendency (ambidextrous, a tendency to and manifest left eye dominance or left handedness) is interesting. In right dominance, there is a strong trend for the score with the first goggles (no occlusion) to be the highest (71.4%). In the shooters with a left tendency, the opposite effect is apparent when only one subject (14.3%) had a higher score with the first goggles than either of the occluded pairs.

Two of the subjects had perfect 10, 10, 10 scores, and one reported that extra concentration was needed to maintain shooting discipline when an eye was occluded. A third, fairly novice subject (nw), who was hardly able to hit a single target with the un-occluded goggles,

found that his scores were better with occlusion and was pleased to be shown a means of improving his shooting.

Clay shooters

Effect of right and left occlusion

The results show that occluding the right eye significantly impairs performance ($p = 0.024$), but occluding the left eye actually enhances performance, increasing the overall score (111). Although this enhancement is not significant, it contributes to an even greater significance in the difference between left and right occlusion ($p = 0.0093$) (Table 7).

Effect of the dominant eye

The subjects' scores were grouped according to dominant and non-dominant eye, irrespective of whether it was their left or right eye. Occlusion of the dominant eye worsened performance ($p = 0.021$) and occlusion of the non-dominant eye improved it significantly ($p = 0.026$). The significance of their effect is most apparent when the scores for the dominant and non-dominant eyes are compared ($p = 0.0001$).

Effect of occlusion in subgroups

The results of the effects of occlusion of the two subgroups – right eye dominant ($N = 7$) and those with a left tendency ($N = 7$) – show that it is the right eye dominant shooter who suffers worse from right occlusion. The shooters with a tendency to left dominance (as defined earlier) were hardly affected. In fact, any occlusion increased their score, though not significantly. The closest to significance was left eye occlusion ($p = 0.097$).

Tennis

Effect of right and left occlusion

Occluding the right eye (all players were right-handed) did not significantly reduce performance, but against expectations occluding the left eye did ($p = 0.013$).

Effect of eye dominance

As with the shooters, the tennis players' scores were arranged by dominant and non-dominant eye, irrespective of whether they were right or left-handed. They were then sub-divided into two groups – right eye dominant ($N = 7$) and left eye dominant ($N = 5$).

It is now becomes clear that the effect of occlusion of the left eye is entirely due to the right eye dominant players ($p = 0.00013$). Neither group was significantly affected when their dominant eyes were occluded and the left eye dominant group remained unaffected whatever the condition (Table 8).

Discussion

In a target sport, it may not be surprising that occluding the aiming eye had more

» **Table 6** Summary of shooting scores and associated dominance

Initial	Dominance		Occlusion			TOTALS
	Eye	Hand	None	R	L	
cd	RRRR	R	10	7	9	26
cd	RRRR	R	5	4	9	18
dt	RRRR	R	10	10	10	30
pd	RRRR	R	10	9	8	27
mo	RRRR	R	9	9	10	29
jr	RRRR	R	9	4	8	21
my	RRRR	R	10	10	10	30
rm	RRRL	L	4	6	3	13
co	RRRR	RL	7	9	9	25
ar	LLLL	R	10	6	10	26
js	LLLL	R	8	2	9	19
ts	LLLL	RL	5	10	4	19
ss	LLLL	R	6	5	7	18
nw	LLLL	L Shoot	1	6	5	12
Average			7.4	6.9	7.9	

» **Table 7** Effect of right and left occlusion

Condition	Probability
No occlusion (104) vs right occlusion (97)	0.0243
No occlusion (104) vs left occlusion (111)	0.839
Right (97) vs left occlusion (111)	0.0093

effect than occluding the non-aiming eye ($p = 0.0093$). It was more surprising that when eye dominance was considered, irrespective of whether it was the left or right eye, this significance increased even further ($p = 0.0001$). Since all the subjects shot right-handed, some of the left eye dominant shooters still shot better when their non-dominant eye was occluded, even though they were aiming with this eye.

The unusually high incidence of left dominance in this group suggests that clay shooting may not be an entirely aiming sport and, in fact, observation confirms that before the shotgun is brought to the aiming position, the clay has to be located. Once the speed, direction and distance have been assessed, the gun is brought to the shoulder, aimed and the shot released.

It appears then that a tendency to left eye dominance is not a disadvantage in clay shooting as it might be in rifle shooting and can predispose participants to the sport. In clay shooting, the sporting

task is the same for all participants and, in fact, in this study, strong right dominant subjects had significantly better results ($p = 0.0001$, Table 14). This begs the question – how do the left dominant shooters compete?

It is possible that although excellent shots, the right dominant shooters are more sensitive to visual disturbance in their right eye. During extended competition, when the normal effects of fatigue-like eye strain, epiphora, tension headaches and retinal bleaching begin to accumulate, their aiming is more likely to be affected. It is also possible that left eye dominant shooters pick up clays better coming from the left. It may be that the left side shooters have powers of adaptation forced on them by the predominance of right-sided equipment. All these subjects have taught themselves to shoot right-handed and are perhaps better mentally equipped to deal with adversity.

It does provide an intriguing insight

» **Table 8** Effect of occlusion of the dominant eye in the two subgroups compared with the whole group

Condition	Whole group	Subgroup dominance	
		Right	Left
No occlusion vs dominant eye occlusion	0.067	0.078	0.450
No occlusion vs non-dominant eye occlusion	0.013	0.00013	0.26
Dominant eye vs non-dominant eye occlusion	0.473	0.37	0.22

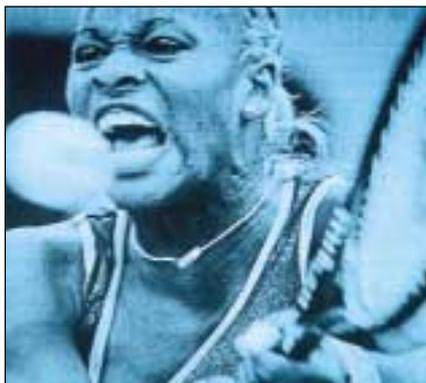


Photo 5

Top tennis player do not look at the racket
(by courtesy of *The Sunday Times*)

into the hard wiring of the brain and its ability to re-learn functions which might normally be associated with the relatively short period of plasticity in youth. Since true dominance does not disappear, there appears to be an ability to superimpose right dominance onto pre-existing left dominance.

Tennis

The original hypothesis was that tennis is an aiming sport like clay shooting (and so many other sports with an aiming element) and that somehow the dominant right eye and right hand would work together to direct the shot. The first clue to this not being the case was the relative size of the target in each sport in terms of angular subtense at the eye. The target tennis players have to aim at is huge by comparison to the clay. The second unexpected clue was that occlusion of the left eye (all the players were right handed) had the most significant effect ($p = 0.013$).

When the groups were split into right and left eye dominant, the significance of this effect appeared to be due entirely to the right eye dominant players, where the significance increased still further ($p = 0.00013$). For the left eye dominant players, it made no difference which eye was occluded. In tennis, as opposed to shooting, scores always went down regardless of which eye was occluded. Overall, the right eye dominant players did have a better average score with no occlusion (15.3 for 10 shots compared with 13.5). As with shooting, it could be argued that left dominance confers durability on the visual system in terms of reduced sensitivity to degradation of acuity.

Conclusion

If we started with the premise that shooting was an aiming sport, then tennis has to be defined in another way, since it is occlusion of the non-dominant eye in tennis which has the most disruptive effect. More than that, it cannot be said that even clay pigeon shooting, is entirely an aiming sport because of the high

percentage of left eye dominance compared with rifle shooting and the pre-shot requirement of depth perception.

It seems that visual performance is as important in tennis as shooting and that tennis is not primarily an aiming sport. The critical visual components in tennis are depth perception and binocular visual acuity (as well as peripheral awareness?). With these two components, the direction and speed of the ball can be anticipated. Using this information and proprioceptive feedback from the arm and wrist, the racket head can be angled for the return shot. The basic requirement is for racket head position is to be parallel to the line of the net or normal to the side markings of the court. Body position is probably judged in relation to these fixed reference points and this is the means by which aiming is achieved. Before and while the ball is being hit, the player is using central and peripheral vision to anticipate his or her opponents next move. The player will not be looking at his or her own racket head (Photo 5).

One reason why occlusion of the left eye had such an unexpected effect in the right eye dominant tennis players is that it could be a measure of the strength of this dominance. When the strong right eye is occluded, it can compensate for some of the blur to maintain a useful level of stereopsis with the left un-occluded eye. When the left eye is occluded, even though binocular vision would seem to be unaffected, the already weaker left eye is unable to contribute usefully to depth perception. Because the angle of the racket head and the timing of the volley depend on anticipating the arrival of the ball, scoring rate is reduced with the non-dominant eye occluded. This is a graphic illustration of how the co-ordination of eye and hand can be disrupted by a visual deficiency.

The importance of visual feedback and learning ability was illustrated in the tennis players in what was, for them, an unusual visual task. Very few of these top class international players were able to score or even hit the target on the first ball of each set of 10, but after the third shot they became more consistent. Fatigue, mental and physical, is likely to have had little effect in either sport since both sets of subjects are used to hours of competition at a much more difficult and intense level.

Laws of visual performance

Based on the evidence of this report, four laws of sporting visual performance are proposed:

1. The primary visual skills in sport are aiming and anticipation, upon which all other skills are based.
2. Visual performance is the controlling external factor in the development and maintenance of sporting performance throughout life (other external factors

which can be influenced by coaching procedures include physiology, nutrition and psychology).

3. Sporting performance is more or less dependant (according to the visual requirements of the sport) on the maintenance of the normal, established relationship between the two eyes.
4. A deficiency in visual performance will inhibit the development of sporting potential through poor eye/hand/body co-ordination, but perfect eyes do not make a perfect athlete. This depends on innate physiology (nature) and psychology (nurture).

These laws apply where vision is the primary sense and would have special applications in monocular athletes.

Practical implications

It seems that vision may affect sporting performance in the most direct way – the ability to hit the target. This could be equated to making a pass in football or netball or scoring a goal, where the target may be a player, an area of the pitch, or the space between the goal posts. In this research, vision is deliberately degraded, in real life it can change insidiously and the subject may be unaware of the deficiency. The study concludes that a sudden reduction in monocular vision (depending on the sport and which eye is dominant) adversely effects aiming, stereopsis and competitive performance in visually demanding sports such as tennis and clay shooting. It is also speculated that a gradual reduction of uni-ocular vision would have a similar effect. However, the manner in which the visual system adapts to, and compromises, for such a dysfunction is a question that needs to be answered.

The evidence of this report may help to persuade sporting institutions that the athletes in their charge could be disadvantaged if they do not have the opportunity of regular visual assessments.

Summary

- The effect of the dominant eye seems to vary according to the demands of the sport, depending on whether it is an aiming sport or one that requires accurate depth perception. In reality, most sports are likely to contain elements of both
- Partial occlusion in shooting of the non-dominant eye actually improved some of the scores; in one case, the shooter could not hit the target without it
- It may be possible to train the dominant eye using occlusion therapy; this learnt dominance would be superimposed on top of natural dominance. This may have implications in our understanding of cerebral plasticity and the importance of change

and learning in the maintenance of intellectual capacity

- Vision appears to affect sporting performance in the most fundamental way, the ability to keep the ball in play (hit the target on the opponents part of the court), hit the clay and it could be suggested, to score goals. For most team managers, regular visual assessments may be an essential pre-requisite to the maintenance and improvement of overall sporting performance

Acknowledgements

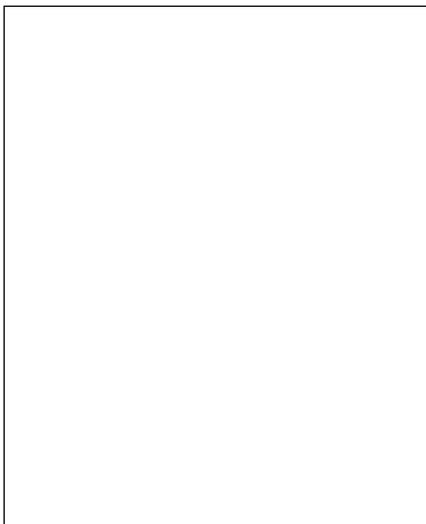
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About the author

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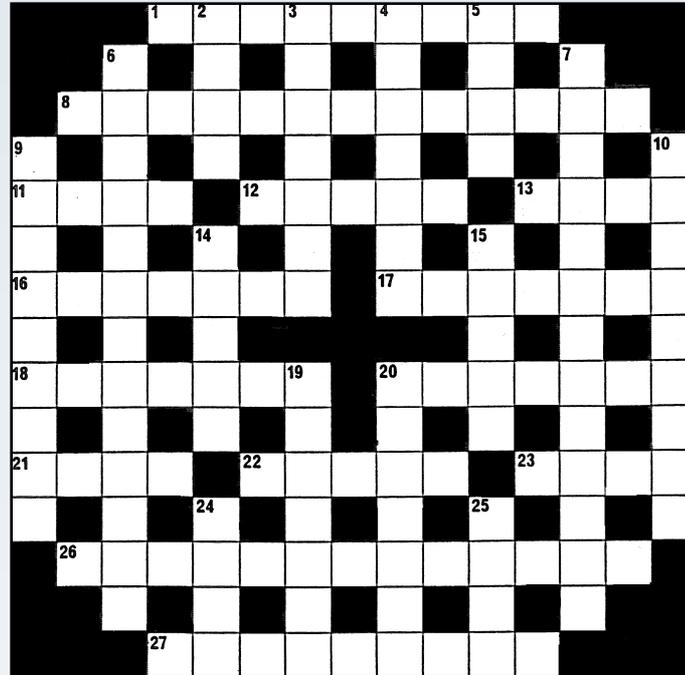
References

For a full set of references, email nicky@optometry.co.uk.



Summer crossword

Flex your mind muscles with this year's Summer crossword and you could win a £50 Marks & Spencers voucher.



Across

1. Spot a large whisky (3, 6)
8. Good reason for the weatherman to consult an optometrist (3, 10)
11. Musical work by Verdi heard in Maida Vale (4)
12. Unclouded (5)
13. 'Fame is the ____' (John Milton) (4)
16. Temporal or materialistic (7)
17. Oddly, red nose shows approval! (7)
18. Delboy's horse takes a canter (7)
20. In crumpled poster I give sharp reply (7)
21. Rice wine (4)
22. Walking stick for Summer Wine's Kathy (5)
23. Poker stake found in Canterbury (4)
26. Vision of a raptor... (4, 4, 1, 4)
27. Astrologers may, drivers certainly should (4, 5)

Down

2. Revealing a touch of 10 Down (4)
3. Put on show (7)
4. Feeling of pique or resentment (7)
5. Calm before the storm (4)
6. Apply cosmetic to primates who assisted the gunners (6, 7)
7. The latest information (4, 5, 4)
9. Be examined – but failure to reach satisfactory standard may result in correction! (4, 1, 4)
10. Orbs which appear to be ecologically friendly (5, 4)
14. Eighth letter from Greece (5)
15. Skilful (5)
19. Cogitate again (7)
20. Invigorate (7)
24. Norwegian city unusually goes solo (4)
25. Briefing for the Family Health Services Authority (4)

Name: _____
 Address: _____

Send your entries to OT (Optometry Today/Optics Today), Summer Crossword, Victoria House, 178-180 Fleet Rd, Fleet, Hampshire GU51 4DA no later than September 16.