The Significance of Eye Dominance and Unilateral Fogging of Vision on Sporting Performance

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Abstract

Background: Research has shown that the incidence of eye-hand dominance varies from one sport to another and that a particular configuration may predispose athletes to that sport. This paper aims to show that blurring or fogging of the dominant eye, can provide a protocol to scientifically prove the dependency of sporting performance (and by implication all other occupations) on vision. Two sports were compared Clay Target Shooting and Tennis.

Objective: To show that there is a measurable link between unilateral fogging of vision to 6/15 (equivalent to uncorrected myopia of -1.00 or astigmatism of -2.00) sporting (occupational) performance.

Method: The clay shooters took 10 shots in 3 conditions. The shooters scored one for a hit and zero for a miss.

The tennis players hit the balls delivered from the end of the court at an archery target 3 metres to their left, in the same sequence of conditions. They scored 3 points for hitting the gold or the blue, 2 for the red or black, 1 for the white and 0 for a complete miss.

All but one of the subjects had 6/6 (0.0 LogMAR) vision or better in both eyes. Their eye, hand and foot dominance was recorded.

Conclusion: The results show that monocular fogging of vision equivalent to low levels of uncorrected myopia or astigmatism significantly affects performance in sport.

Apparatus: A launcher was used to deliver the clays to a point about 30 metres distant from the shooters. An archery target was used for the tennis players to aim at, the balls were delivered on the volley by a “Lobster” machine. Afocal sports goggles were used to carry out the sporting task in three different conditions, no fogging, right eye fogged and left eye fogged.

Results:

Clay target shooters: When the group was divided into shooters who were right eye dominant, right handed and right footed (Type I) and those with any left tendency (Type II), the Type I shooters showed a significant worsening of performance with their dominant eye fogged compared to no fogging (p = 0.0057, N = 7).

Tennis players: The players showed a significant worsening of performance with their non-dominant eye fogged compared to no fogging (p = 0.0047, N = 12). When the Tennis players were divided into Type I and II, Type I showed a significant effect when their non-dominant eye was blurred (p = 0.0053, N = 7).

A two-tailed T test with equal variance was used throughout.

Keywords: Eye Dominance; Non-Dominant Eye; Dominant Eye; Type I Dominance; Type II Dominance; Tennis; Clay Target Shooting; Monocular Fogging; Eye Hand Dominance; Sporting Performance; Left Tendency; Bangerter Foil; Sports Goggles; Myopia; Astigmatism; Binocular Vision; Binocular Deficiency; Peripheral Awareness; Visual Performance; Dispensing; Optometry; Visual Profile; Angular Subtense, Visual Task Analysis

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Abbreviations
UK: United Kingdom; ASvP: Association of Sport and Schoolvision Practitioners; SVUK: Sport and School Vision UK; BV: Binocular Vision; FD: Fixation Disparity; MCOptom: Member of the College of Optometrists; M.ASvP: Member of the Association of Sport and Schoolvision Practitioners; BSI: British Standards Institute; V: Versus

Introduction
There is growing interest in the importance of vision in sport. Elite athletes acknowledge that vision is important or very important [1] but may not always understand the advantage of regular eye examinations to maintain sporting performance. Part of the difficulty is that there is no strong scientific link between vision and sporting performance.

Vision therapy
Athletes and coaches tend to concentrate on the effect of vision therapy or training on sporting performance. Many teams and athletes now engage the services of vision consultants who may be Orthoptists, Sport Scientists, Sports Physiologists or Optometrists. The success of England in the 2005 rugby world cup was in part attributed to their vision expert and anecdotally reinforced by the same consultant "leading" South Africa to world cup success in the 2007 games [2].

Premiership football teams Manchester United and Chelsea have vision specialists on the staff. Vision consultants were associated with the unexpected victory of Ireland against Pakistan in the 2007 Cricket World Cup [3].

Although there is little scientific evidence to support the relationship between the therapies given and an improved team performance [4,5] the consultants are there at the invitation of the teams, who must be seeing an effect to justify their services. Therapy is often viewed as a panacea in the same way that athletes train with weights, drills and event preparation. The irony is that in sport itself the relationship between training and athletic performance is not fully scientifically established [6,7].

This approach to therapy or exercise follows the principle that if an exercise is good for one it is good for all but it avoids identifying those who are in need and those who may not be. This can be a concern with vision where a treatment or therapy given inappropriately could make things worse.

Vision correction
It could be argued that vision correction will have an even more direct and measurable effect on sporting or occupational performance. It seems obvious that a partially sighted tennis player will always struggle against someone with good sight. People make repeated visits to their optometrist over a lifetime as their vision changes and find anecdotally the new prescription has a positive effect on their occupational performance. Surprisingly there is no scientific evidence to support this either. The driving standard for instance is based on an intuitive guess [8,9] and is nevertheless enshrined in UK law.

A scientific methodology to support the relationship between vision and sporting performance would make it easier to identify players at risk and therefore to know when and how to treat a visually related sporting deficiency. It would also make it easier to decide between vision therapy (eye exercises) and vision correction (spectacle and/or contact lenses) for the best course of action. This would have implications for all other occupations. Sport is just one example of an albeit diverse occupation, often carried out at a high level of visual demand.

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Eye dominance

The measurement of eye dominance has been established [10,11] and seems to parallel the asymmetry of the brain that is broadly divided into left and right hemispheres, having different and complementary functions [12].

The consideration of ocular dominance in sport is often anecdotal and is understood in the context of aiming. Various terms are used to describe dominance including sensory [13] and ocular [11] and each has its own method of measurement. In rifle shooting eye dominance is measured by methods, which often vary from coach to coach [14] but is usually found to be the eye, which gives the best results when placed behind the near sight of the rifle in line with the foresight (on the end of the barrel of the gun) and the target (See figure 1 traditional aiming). It is likely that the aiming process, to a greater or lesser extent will contribute to success in sport and perhaps less critically in all other occupations.

Figure 1: Traditional aiming in right eye dominance (Courtesy Graham Oades).

The relationship between hand and eye dominance

During the years of its development SVUK has collected data from many elite groups of athletes [15-21] and one of the interesting patterns to emerge is the relationship between specific sports and hand and eye dominance [22]. The data confirms that eye dominance is not an infallible predictor of hand dominance and that the incidence of hand/eye dominance varies from sport to sport (See table 1 Incidence of hand/eye dominance in sport). This relationship between eye and hand dominance appears to be important and may predispose individuals to particular sports.

<table>
<thead>
<tr>
<th>Dominance</th>
<th>Cricket Scottish</th>
<th>Archery</th>
<th>Football</th>
<th>Rifle G.B. Junior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye</td>
<td>Hand</td>
<td>National N = 15</td>
<td>Internationals N = 16</td>
<td>Coaches N = 70</td>
</tr>
<tr>
<td>Right</td>
<td>Right</td>
<td>46.7</td>
<td>62.5</td>
<td>84.3</td>
</tr>
<tr>
<td>Left</td>
<td>Left</td>
<td>6.6</td>
<td>18.75</td>
<td>10</td>
</tr>
<tr>
<td>Right</td>
<td>Left</td>
<td>6.6</td>
<td>6.25</td>
<td>2.85</td>
</tr>
<tr>
<td>Left</td>
<td>Right</td>
<td>40</td>
<td>12.5</td>
<td>2.85</td>
</tr>
</tbody>
</table>

Table 1: Incidence of hand/eye dominance in elite sport %.

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If this predisposing factor were true then it is likely that blurring or fogging the dominant eye would have an effect on sporting performance. This could provide a means to demonstrate the relationship between vision and sporting performance contemporaneously, where early longitudinal research based on eye exercises and therapy could not [23-25]. This would have implications for all other occupations.

Hypothesis

It was proposed that fogging (blur) of the dominant eye would have an adverse effect on the ability to aim at or hit the target even without a reduction in binocular vision [26]. Aiming is used in its broadest sense to include ball catching, kicking a football at the goal, motor motor racing (aiming at the crown of the bend) as well as in target sports. It was also proposed that racket sports would be affected in the same way, although it was difficult to say how aiming happens when a lining up of ball, racket and eye does not usually occur.

Materials and Methods

Subjects

Two groups of athletes were studied; on the 22 June 2002, 14 Club and National-level Clay Target shooters from the Braintree Shooting Club in Essex (average age 42.3 sd 11) and 12 Tennis players during the Marsh Classic at the Hurlingham Club, Fulham (18.2.02.) including winners and finalists at Wimbledon, the Australian, French and US open championships (average age 43.6 sd 8.2). The relatively small numbers were a consequence of testing elite groups, which by definition are usually small and difficult to bring together in one place.

Equipment

An analytical test was devised for each group, which reflected an important part of their playing skill.

Tennis analytical test

The tennis players who were all right handed stood on the half way line of the court and received balls from a volleying machine (See figure 2 The Lobster) at about chest height, delivered from the service line. The speed and direction were reasonably consistent but not entirely predictable.

Figure 2: The Lobster.
They were asked to hit balls against an archery target. Players scored three for hitting the gold or red, two for hitting the blue or black, one for the white and zero for a complete miss (See figure 3 Player and researcher position).

**Figure 3:** Player and researcher position.

**Clay target shooting analytical test**

The shooters were asked to fire at clays launched to a distance of about 30 metres (See figure 4 clay target launcher and figure 5 shooting position). A hit scored one and a miss zero. All shooters were asked to keep both eyes open but one shooter had to close his left eye at the point of firing (See figure 6 Left eye dominance in shooting off the right shoulder).

**Figure 4:** Clay target launcher (grey discs used in this research).
Targets
In clay shooting the target was an 11 cm diameter grey disc (The Clay) at a distance of about 30 metres (See figure 7 distance and size of target in clay shooting). In tennis it was an archery target diameter 80cm at a distance of 3m (see Fig 8).

Apparent target size (visual angle)
A consideration of the skills in an individual sport (occupation) needs to take into account the target size and speed (visual task analysis). The angular subtense at the eye of the clay at 30m being much smaller than say the static archery target at 3m (See table 2 target size
and angular subtense at the eye in Clay Target Shooting and Tennis). It could be argued that the real target size in novice tennis is even less exacting than the archery target being the size of the court on the opposite side of the net.

<table>
<thead>
<tr>
<th>Target</th>
<th>Shooting</th>
<th>Tennis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The Clay</td>
<td>Archery Target</td>
</tr>
<tr>
<td>Gold</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Whole Target</td>
<td>3000</td>
<td>300</td>
</tr>
<tr>
<td>Target size cm</td>
<td>0.0037</td>
<td>0.0533</td>
</tr>
<tr>
<td>Distance</td>
<td>12 minutes</td>
<td>3 degrees</td>
</tr>
<tr>
<td>Archer target (gold) Vs size of clay</td>
<td>15 x bigger</td>
<td></td>
</tr>
<tr>
<td>Whole archery Target Vs size of clay</td>
<td>75 x bigger</td>
<td></td>
</tr>
</tbody>
</table>

For comparison in a 10m rifle target the bull is 1cm in diameter, which gives an angular subtense at the eye of tan 1/1000 = 3.4 Minutes

Table 2: Target size (cm) and angular subtense at the eye in clay target shooting and tennis.

Figure 7: Distance and size of target in clay shooting (not to scale).

Figure 8: Distance and size of the archery target in tennis (not to scale).
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Method

Hand and foot dominance

Both groups were asked to say with which hand they wrote and which foot they kicked a ball.

Eye dominance (Hand over hand method)

Eye dominance was measured using a repeated hand over hand method (to eliminate left right bias) [22]. The particular advantages of this method are the symmetry of the subject looking at the observer’s nose rather than one eye or the other and repetitions using each hand in turn on top, to prevent a left or right bias. The method always produces a result as long as the aiming gap is small enough (about the size of a GB 50p piece), even though there may occasionally be hesitation (which itself can be indicative of a pre-existing binocular conflict).

The observer recorded the eye that could be seen through the gap. For strong right dominance the result would be recorded RRRR (4/4). A left tendency might be recorded RLRR (3/4). A greater left tendency (weak eye dominance) would be recorded RLRL (2/4), the dominance changing with the position of the hands. Strong left dominance would be recorded LLLL (0/4) (See figure 9 Measurement of eye dominance).

![Measurement of eye dominance](image)

Figure 9: Measurement of eye dominance.

Monocular Fogging

The tennis players and clay shooters wore three sets of plano sporting goggles (clear lenses, right eye fogged and left eye fogged) and took 10 shots in each of three conditions (see Fig 10 Sporting goggles).

Fogging the vision

Blurring or fogging the vision with a refracting lens (plus, minus or cylindrical) would have a variable effect, depending on the subject’s own refractive error. This is apart from the cost and impracticalities of testing these athletes before the event. Therefore a Bangerter Foil [27] was used, to produce a measurable amount of fogging in the subjects. The foil graded as 0.4 (which represents the Snellen equivalent

Prior to carrying out the task the athletes’ high contrast LogMAR vision as they played sport, with or without correction was recorded. All except two subjects had 6/6 (0.0 LogMAR) vision or better in both eyes. This overcame one potential weakness of the study (unavoidable within the time constraints), that sporting performance was measured as the athlete normally played without knowing individual refractive errors. Only one (Tennis player) was worse than 6/6 in both eyes (0.2 LogMAR R&L).

**Presentation of goggles**

In both sports each player was given the clear goggles first so that any learning effect (practice wearing goggles) would tend to diminish the significance of the results, these were followed by the pair with the right eye fogged and then the pair with the left eye fogged. All thirty trials were taken (10 in each condition) without a break except to change goggles.

Ideally the goggles should have been randomly presented to the athletes, but the time constraints particularly with the tennis players would have made this impractical. A degree of randomness was achieved with the fogging goggles because eye dominance varied from one player to another and the right eye blur was always given first irrespective of eye dominance which was not known to the researchers measuring sporting performance.

It was also thought important that players achieved a rhythm approximating to normal play; changing goggles between shots would have disturbed this. It could also be argued that that playing 10 consecutive shots with the same eye blurred would diminish the significance of the results not increase it, as the athlete became accustomed to the monocular blur in that eye.

**Recording Results**

**Tennis**

Wearing the goggles in each of the three conditions the players had to direct 10 deliveries (30 altogether) onto an archery target at a distance at about 3 metres, placed on their left at 90 degrees to the direction of the ball (see Fig 3 Player and researcher positions). The
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clear goggles were used first to try to minimise the effect of learning on significance in the second and third sets of trials. All the players held the racket in their right hand (despite 2 players being naturally left handed) so they played a forehand shot to their left to hit the target.

**Clay target shooters**

Similarly, the shooters took 10 shots in each of the 3 conditions (See figure 5 shooter and researcher positions).

In each sport the researchers who scored the results were different from those who assessed LogMAR vision and dominance type. There was no interchange between the groups of researchers until all the data has been collected. The athletes themselves did not know what the effect of dominance type would have on the final results.

**Results**

Incidence of eye hand dominance (See table 3).

Analysis of clay target data

The shooters’ data was adjusted so that the scores for the whole group represented dominant and non-dominant eye fogging. It was then adjusted back to reflect fogging of the right and left eyes irrespective of dominance (See table 4).

Finally the data was arranged into shooters with a dominant right eye, hand and foot (All Right- AR) and (shooters with any left tendency in eye hand or foot (Left Tendency- LT)), AR scores were significantly affected when their dominant eye was fogged (p=0.0057). LT was affected but not significantly (p=0.083). Fogging the non–dominant eye had no effect on AR or LT.

The two groups’ (AR and LT) dominance scores were compared (See table 5).

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Analysis of the tennis data

The tennis data was analysed as a whole and then organized into AR and LT. The players showed that fogging the non-dominant eye had a significant effect on the ability to hit the target ($p=0.0047$). Separating the data into AR and LT confirmed this effect was largely due to AR ($p=0.0053$). LT was unaffected when the non-dominant eye was fogged ($p=0.33$). The un-fogged scores of the two groups showed no difference (see Table 6).

<table>
<thead>
<tr>
<th>Score</th>
<th>Probability (significant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Right (AR)</td>
<td>1.44</td>
</tr>
<tr>
<td>Left Tendency (LT)</td>
<td>1.50</td>
</tr>
</tbody>
</table>

*Table 6: Mean scores for AR v LT Tennis players (No fogging).*

The data analysis is summarised for both sports in table 7.

<table>
<thead>
<tr>
<th></th>
<th>Fogged Eye (v No fogging)</th>
<th>Whole group</th>
<th>Type I (N = 7)</th>
<th>Type II (N = 7 Clay, N = 5 Tennis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay Dominant</td>
<td>0.88</td>
<td>0.0057</td>
<td>0.083</td>
<td></td>
</tr>
<tr>
<td>Non-Dominant</td>
<td>0.88</td>
<td>0.76</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Tennis Dominant</td>
<td>0.18</td>
<td>0.074</td>
<td>0.92</td>
<td></td>
</tr>
<tr>
<td>Non-Dominant</td>
<td>0.0047</td>
<td>0.0053</td>
<td>0.33</td>
<td></td>
</tr>
</tbody>
</table>

*Table 7: Summary of the significance of unilateral fogging on sporting performance in clay target shooting and tennis. For significance $p < 0.05$ (two tailed T test equal variance).*

Discussion

Clay target shooting

It was predicted that in a sport like Clay Target shooting fogging the dominant aiming eye would have a significant effect on the ability to hit the target. Unexpectedly the group as a whole showed no significant effect when the dominant eye was fogged compared with no fogging. Neither did fogging the non-dominant eye have any effect.

The probability (of no difference) reduced when the data was adjusted to compare fogging with no fogging for the right and the left eyes, but not significantly.

Incidence of eye hand dominance in tennis and clay shooting

The incidence of Right eye and hand dominance in these groups did not conform to the previously tabulated sports (Table 1). This is more surprising in the Clay Shooters (46%) whose sport to the lay observer is apparently similar to the predominately aiming sport of rifle shooting (~90% right eye and right hand).

The right eye, right hand clay shooters however were still the largest group. The unifying characteristic of the other three groups was that all showed some manifestation of left dominance in eye, hand or foot (Table 3). This formed a natural division between the shooters who were either completely right dominant or had any left tendency in eye, hand (or foot).
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When the shooters were divided in this way the right dominant group (AR) was significantly affected when their dominant eye was fogged ($p = 0.0057$). The group with any left tendency (LT) was not affected ($p = 0.083$). This startling result suggests these two groups have a different visual profile, which for convenience were named:

- Type I dominant; right eye dominant, right hand and foot.
- Type II dominant, any left tendency in eye, hand or foot.

**Tennis**

Once the results had been established in the shooters a similar pattern was expected in tennis although the problem of what part the aiming process played remained unresolved.

The findings were again completely unexpected. When the tennis scores with the dominant eye fogged were compared with no fogging for the whole group there was no significant difference ($p = 0.18$). It was fogging the non-dominant eye that caused the players the biggest problem ($p = 0.0047$). And again when the group was divided into Type I and II, it was Type I which was affected when the non-dominant eye was fogged ($p = 0.0053$). Fogging the non-dominant eye of Type II moved towards a difference but not significantly ($p = 0.074$).

**The role of aiming in tennis**

This suggested the dominant aiming eye was not as important in tennis, as it was in clay target shooting at least for Type I athletes. This makes it unlikely that tennis is an aiming sport in the traditional sense.

What seems to be important in tennis, is anticipating the arrival of the ball at the racket face to create time for the player has to get in position to receive it. An estimate of direction and speed of travel is needed to make this judgement. Movement of the ball relative to the dominant eye would determine direction but judging speed is the more difficult skill. This would be done by iterative calculations by the brain of the changing distance of the ball as it approaches.

**The importance of depth perception**

The judgement of speed of approach depends on depth perception, which at its highest level is stereoscopic. Stereopsis depends on accurate inter-ocular coordination based on the fixation disparity between the two foveal images, which is constantly changing (getting bigger) as the object approaches. It is the brain’s ability to use this information to anticipate the arrival of the ball, which makes it possible to play tennis. If the player had to wait until it arrived at the racket it would be impossible to react fast enough to make the shot.

**The importance of eye dominance**

Stereopsis also depends on a stable (one might say rock steady) dominant eye. It is the stability of the dominant eye, which allows the non-dominant eye to fine tune stereopsis. In effect the dominant eye is the workhorse, which allows the more sensitive non-dominant eye to fine tune depth perception.

It may not be a coincidence that Type I shooters with the strongest eye dominance are the ones who excelled (see Table 5).

**The primary visual skills**

It appears then that the primary visual skill in Clay Shooting is aiming and in Tennis depth perception. It is not surprising that target size reflects these primary skills. The effective size (angular subtense at the eye) of the clay is far smaller than half a tennis court. By comparison the target size in rifle shooting is even smaller.
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The implications of target size

It seems reasonable to argue the angular subtense at the eye of the target will give a guide to which of the two primary visual skills is more important. This would predict that aiming in rifle shooting (3.4 minutes of arc) is critical, but not quite so much in Clay target shooting (12 minutes of arc) and least of all in Tennis (12 degrees 33 minutes). This could explain why Type II can still do well because another skill can compensate for the loss strong right dominance. It could be argued that in all sports at the elite level the overall physiological demand remains the same, where one skill is skill is diminished another will compensate.

Depth judgement in clay shooting

This may explain why the incidence of right eye and hand dominance is so much lower in clay shooting than rifle, the scatter of the shot in Clay gives even more margin for error. Although the data suggest aiming is very important in clay target shooting, depth perception must also play a part. For instance, a clay travelling across the field of view will appear to move slower the further it is away so it is important for the shooter to be able to judge this distance to compute its actual speed. This will have a critical bearing on how far the shooter will aim ahead of the clay to make sure the shot arrives at the target area at the same time as the clay.

Aiming in tennis

In tennis on the other hand the basic target is enormous (the other side of the net) so the aiming task if it exists is likely to be subliminal and have very little to do with eye dominance. It is likely the player judges their position by being peripherally aware of the court markings and the net. This would seem to be why the dominant eye is important in shooting and the non-dominant in Tennis.

Depth judgement and non-dominant fogging in tennis (Monocular clues)

The remaining question is why fogging the non-dominant eye in tennis is so disabling to Type I given the importance of stereopsis in tennis where both eyes work together to judge depth.

The key to this may be the strength of Type I’s eye dominance arguably as nature intended, given their success in Clay shooting. In this ideal relationship between the eyes, stereopsis will be maximised as the best way of judging depth. But stereopsis is not the only way of judging distance. It can also be done using monocular clues. The distance of an object can be judged by one eye because its size changes as it comes towards the player, the atmosphere also fades the view as the object moves farther away. A phenomenon called parallax can also be used where an object will move faster than its back ground the nearer it is to the player. In the absence of good binocular vision people even with only one eye, can become expert at using these clues.

Monocular clues and a left tendency

These monocular clues can give an appreciation of depth but it is never as good as full stereopsis. When there is a left tendency it is likely full stereopsis will be diminished because of the effect it has on the stability of eye dominance. In these circumstances Type II will be bound to revert to monocular clues when their dominant eye is fogged to make up the deficit. If binocularity is disrupted as it was in the research they will be less likely to be affected. Players who were born with “perfect” vision and have never needed to learn how to use these clues will be relatively disabled when one or other eye is fogged.

This much may have been predictable, but it was fogging of their non-dominant eye specifically causing the disruption, that was completely unexpected.

Type I’s Achilles heel

It appears that the very strength of Type I’s right eye dominance was their Achilles heel. The strength of this dominance was such that even if the dominant eye were fogged it was still able to work with the non-dominant eye to maintain a good level of stereopsis. If the weaker, more sensitive non-dominant eye was fogged it more or less give up the ghost, as the visual system was swamped by the strength of the dominant eye (the player effectively becoming monocular) and therefore unable to contribute to meaningful stereopsis. What made things even more difficult for Type I was that it probably did not occur to them there was a visual problem. This can be quite distressing (sometimes audibly during the research) because the players’ distance vision would be apparently unaffected.

The same principle is likely to have applied to the shooters, where Type II could rely on monocular clues to judge depth even though they may have had an inherent instability in their dominant aiming eye.

Conclusion

Unilateral fogging, which might occur naturally as uncorrected myopia of around -1.00 Sphere or astigmatism say .../-2.00 Cylinder does have a direct effect on sporting performance. This cannot be understood scientifically with out reference to eye dominance.

There are two dominance types identified in tennis and clay shooting:

- Type 1: Right eye dominant with a dominant right hand and foot.
- Type II: Any left tendency in eye, hand or foot.

These two types have physiologically different visual profiles, which reflect their individual adaptations to dealing with the visual demands of these two sports.

Two primary visual skills were also identified. In clay target shooting this is the ability to aim due to the dominant eye although depth perception also plays a part. In Tennis it is the ability to anticipate based on depth perception, dependent on the non-dominant eye. A subliminal aiming facility in tennis is dependent on peripheral awareness. It is likely that in all sports and other occupations these two skills will be represented in differing proportions.

In clay target shooting fogging the dominant eye has a significant effect on the ability to hit the target, this is particularly true in Type I. In Tennis it is fogging of the non- dominant eye, which has the greater effect again in Type I. Type I may be the more visually gifted but Type II is likely to be less susceptible to low levels of uncorrected refractive error.

Monocular fogging has important implications in the correction of binocular visual deficiency in different sports (and all other occupations), which is dependent on the accuracy of refraction and dispensing and their relationship to performance.

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Conflict of Interest
There is no conflict of interest.

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