

## Eye Dominance - Awareness Revolution

Richard Hughes, Geraint Griffiths, Jim Hartnett

### Introduction

Around 1993, American PGA pro Jim Hartnett started noticing inconsistencies in the swings of PGA West and tour players and realized eye dominance was the critical component.

Ten years later, Sportvision optometrist Richard Hughes, in beautiful Galway Ireland, was also trying to convey the importance of eye dominance in golf. Jim and Richard had never met. In 2017 Jim published "Golf for the other 80%" which focuses on eye dominance. Three years later Richard read Jim's book and realized that vision theory and Jim's coaching experience were in complete harmony and that nobody else knew or understood this.

Theory may now be able to explain why the majority of tour players are cross dominant, left eye dominant and right-handed or vice versa, and why there are so few with a dominant right eye who are right-handed.

### The Cone of Vision

Golf is a highly visual sport. Vision is by far the most important sense, from which most sporting skills emanate<sup>1</sup>. It is therefore the first place to look for problems.

The way the eye sees the world could be considered a cone of vision. At the centre of the cone is the fovea, the most sensitive part of the vision on the retina. As vision spreads out from the centre (the peripheral vision), it becomes less sensitive to detail but far more sensitive to movement and shape.

When the eye is static the brain will take information from every part of the cone (visual field) central and peripheral. In the drive for instance, the centre of the cone will be focused on the back surface of the ball, while the outer part of the cone will be tracking the path of the down swing as the image of the club traverses the peripheral retina.

Timing the shot and confidence in the final acceleration to impact are dependent on the movement and direction of the hands, shaft and club, seen peripherally. This is a highly refined skill in elite players. The importance of the outer parts of the cone could be illustrated by attempting to drive off the tee in blinkers.

### Bi Foveal Fixation

The visual process in one eye is already complex but now this complexity is significantly increased by the way the eyes work together. Understanding how the two eyes work together (binocular vision) and the importance of bi-foveal fixation (the centres of each cone working together) is critical to the accuracy and repeatability of perhaps the most important shot in the game of golf - the drive.

### Eye Dominance

Eye dominance is an innate characteristic. It is the platform on which all other visually dependent skills are built. The dominant or aiming eye determines our position relative to the object we are looking at <sup>2</sup>. Once the position of the object is established the non-dominant eye is then used to judge its distance. The distance between the eyes means the image of the object will be slightly displaced from the centre of the fovea in the non-dominant eye. The brain is able to relate this separation to the distance of the object.

### Type I and Type II Dominance

Most people have a clearly dominant eye not least because of the evolutionary advantages of being able to judge position and depth in a forward facing hunter-gatherer. For scientific convenience<sup>3</sup> it is possible to divide the population into two dominance types:

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

The way in which people develop and perceive the world is profoundly affected by their dominance Type. This is reflected in sport where some are better suited to Type I, and others to Type II.

The plethora of sporting choices may be a reflection of the diversity of visual skills more than anything else, which starts with the demarcation of the two dominance types.

Up to 80% of tour players are cross dominant Type II (right handed and left eye dominant or vice versa) compared with the general population where there appears to

be a much higher incidence of Type 1<sup>4</sup>. It is surprising that in a sport of comparable visual difficulty like clay target shooting where aiming is the critical skill, right dominant eye shooters seem to have the advantage<sup>2</sup>. Clay shooters also keep both eyes open, the question is why are there so few Type 1 tour players in golf.

### The Backswing

A fundamental principle of Newton's Law of motion is that the harder a ball is hit the further it will go. It follows that a coaching imperative will be to maximise the backswing when driving off the tee in golf. For a fixed accelerating force (the power of the golfer), the longer the back swing, the greater the speed at the point of impact.

### The Role of Aiming in Golf

A characteristic of aiming sports is that visual attention should never waver<sup>5</sup>. Vision leads the execution of the shot and any deviation of aim during the process of the drive will be magnified at the end of the flight; a five-degree misalignment of the clubface at impact results in a 25m miss at 300 metres.

### The Aiming Skill in Type I Players

Bi foveal fixation will ensure accurate depth perception and ball position (Right eye, hand and dimple on the back surface of the ball all in line). As the club is drawn back a judgement of the distance and position of the ball is maintained throughout the swing. As the backswing continues the head should remain steady to allow the right eye (ball position) and the left eye (distance of the ball) to maintain bi-foveal fixation. If the back swing is extended too far it will force the shoulders out of line and the head to follow.

If the head turns far enough the nose will obscure the vision of the ball in the right eye, when this happens the left non-dominant eye will take over the aiming task. In that instant without the player realising, the apparent position of the ball will change.

### Ocular Dominance and Apparent Ball Position

There are two ways to demonstrate this effect and the underlying importance of ocular dominance:

1. Hold the hands as if they were holding the club and extend the index finger of the right (lower) hand to aim it at the ball with the right eye open. Then close the right eye and open the left eye and see that the ball appears to move to the left (See Fig 1).

If this happens at the top of the swing because the nose obscures the right eye the same thing will happen to the position of the ball. The brain now sees the ball to the left of where it actually is in relation to the hands that would be guiding the club.

2. Holding the club with the lower right hand index finger extended so that the dominant right eye, index finger, shaft and ball /club interface are all in line with the left eye shut (See Fig 2).

This time when the left eye is opened and the right eye shut the club and the ball will not appear to move. The extended index finger on the right hand however will now be pointing to a patch of grass to the right of the ball and club (See Fig 3). You may also observe an apparent movement of the shaft to the left. This shows the clubface and ball have moved because the index finger is now pointing to where they were originally.

The reason that the ball and club do not appear to move is that they are both in the same position relative to each another, so the brain assumes nothing has moved.

Because there has been no apparent movement of the ball and clubface the only way to know that something has changed is the movement of the pointing index finger. This is not easy to see because the eyes ignore the detail of what they are not looking at directly due to a doubling effect that we learn to suppress. This phenomenon is called physiological or normal diplopia (double vision) See Fig 4.

Fig 1 Ball Position

Type I Right eye open, hands clasped as though holding the club with the index finger of the right hand pointing towards the ball

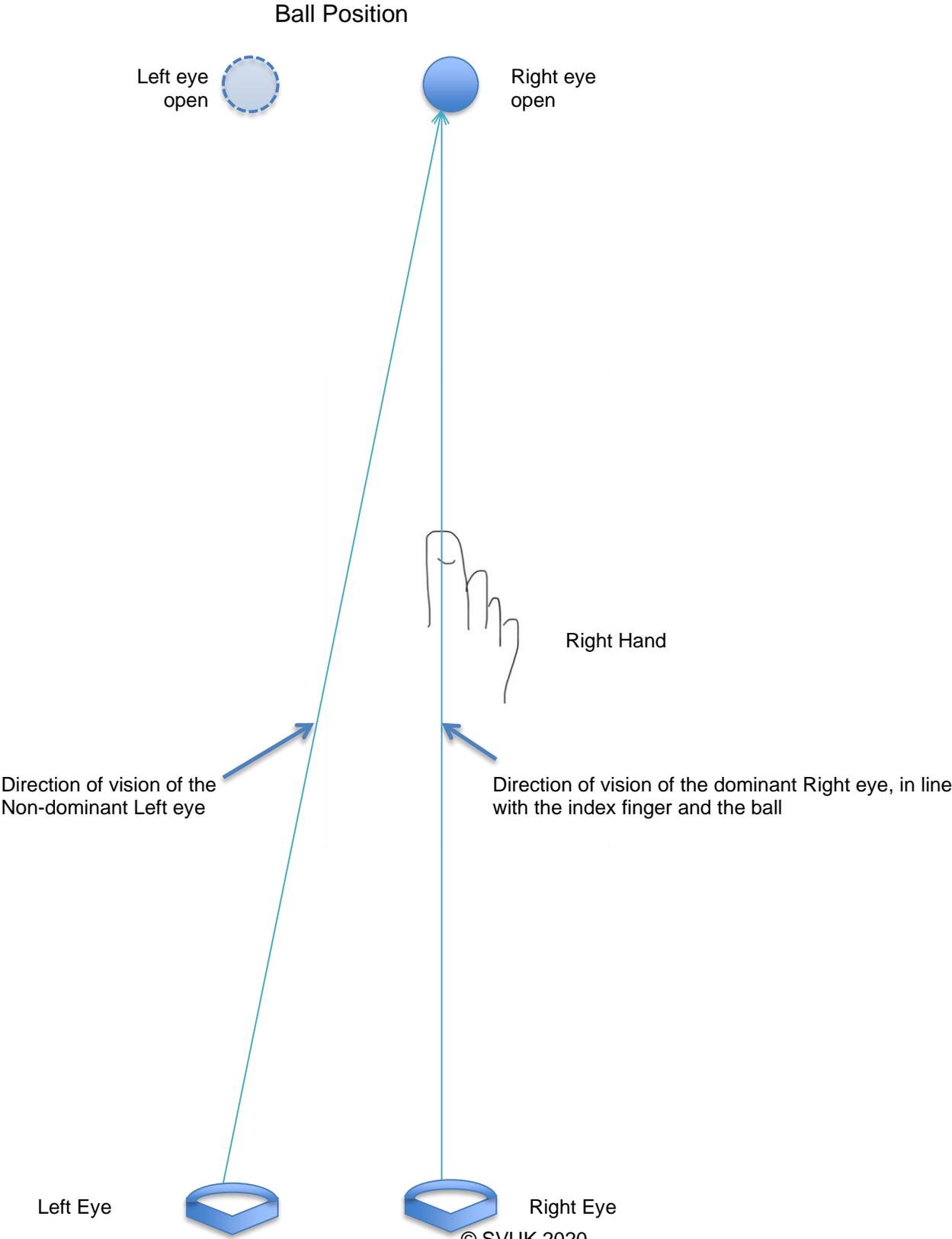


Fig 2 Type I, Addressing the Ball Right Eye Open

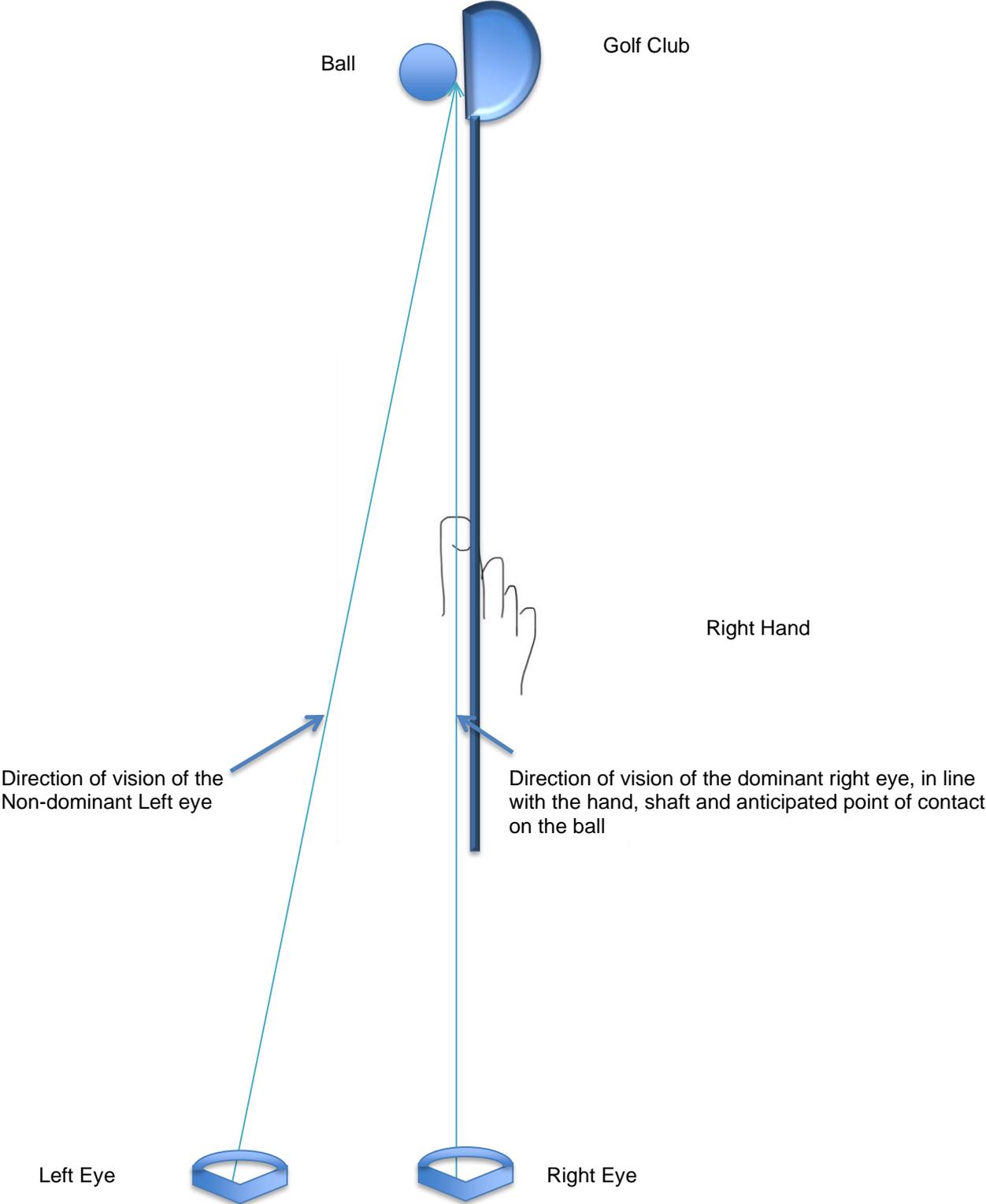
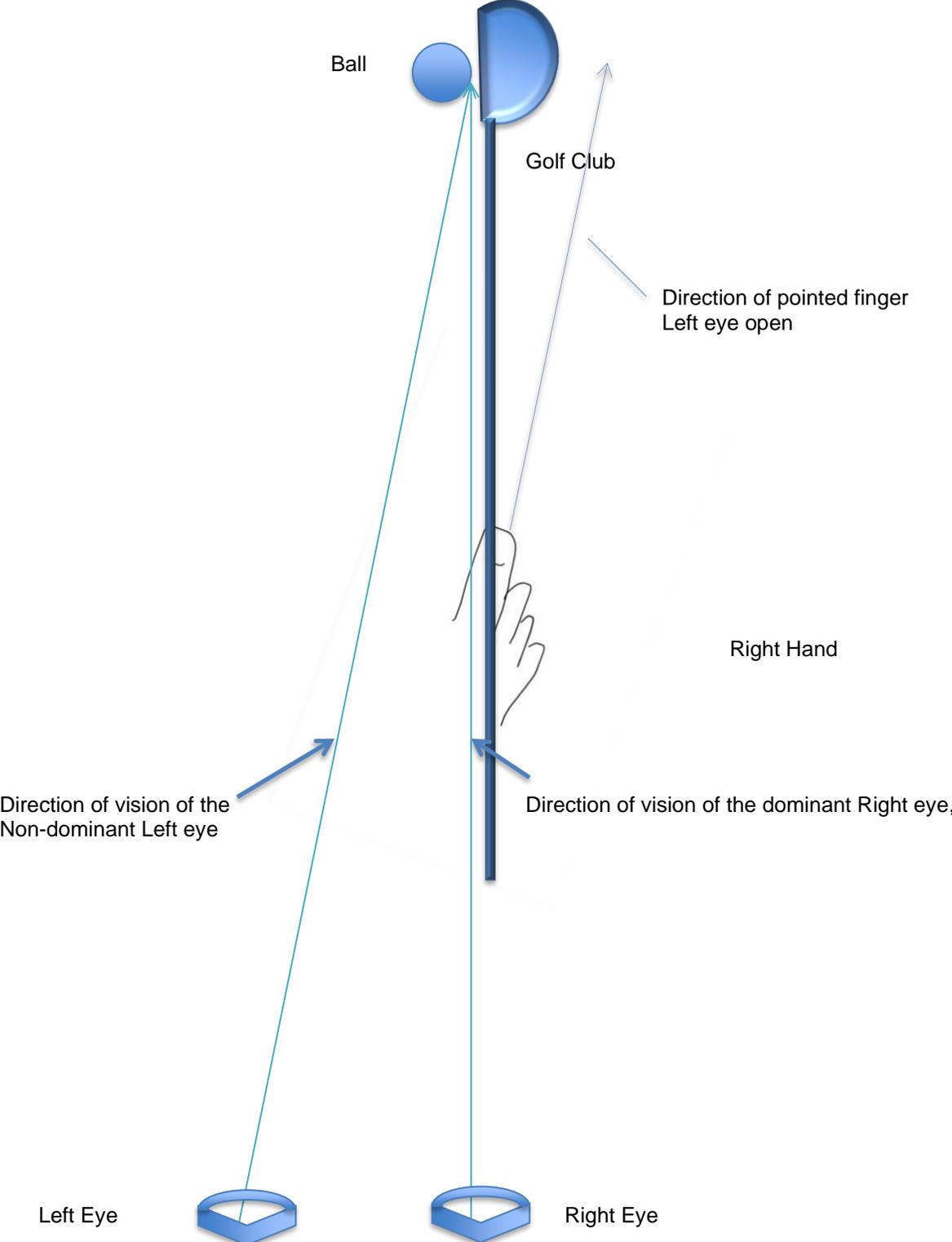


Fig 3 Type I, Addressing the Ball Left Eye Open



## Physiological Diplopia

This phenomenon may be why experienced golfers are sceptical that anything changes (as they address the ball to begin the swing) when they close their dominant eye.

Physiological diplopia can be demonstrated by looking at a golf ball on the floor and holding up a pencil 12 inches from the nose; as concentration is maintained on the ball two pencils will suddenly appear on either side of it (See Fig 4).

When the ball is addressed and attention is on the clubface the detail of what is happening to the hands will be ignored. Extending the index finger of the right hand breaks this illusion because when the left eye is opened and the right eye shut, the finger is pointing to the right of the ball and club.

When there is a long-standing binocular imbalance the visual system compensates by extending its ability to suppress even when both eyes are trying to look at the ball, to prevent unwanted double vision.

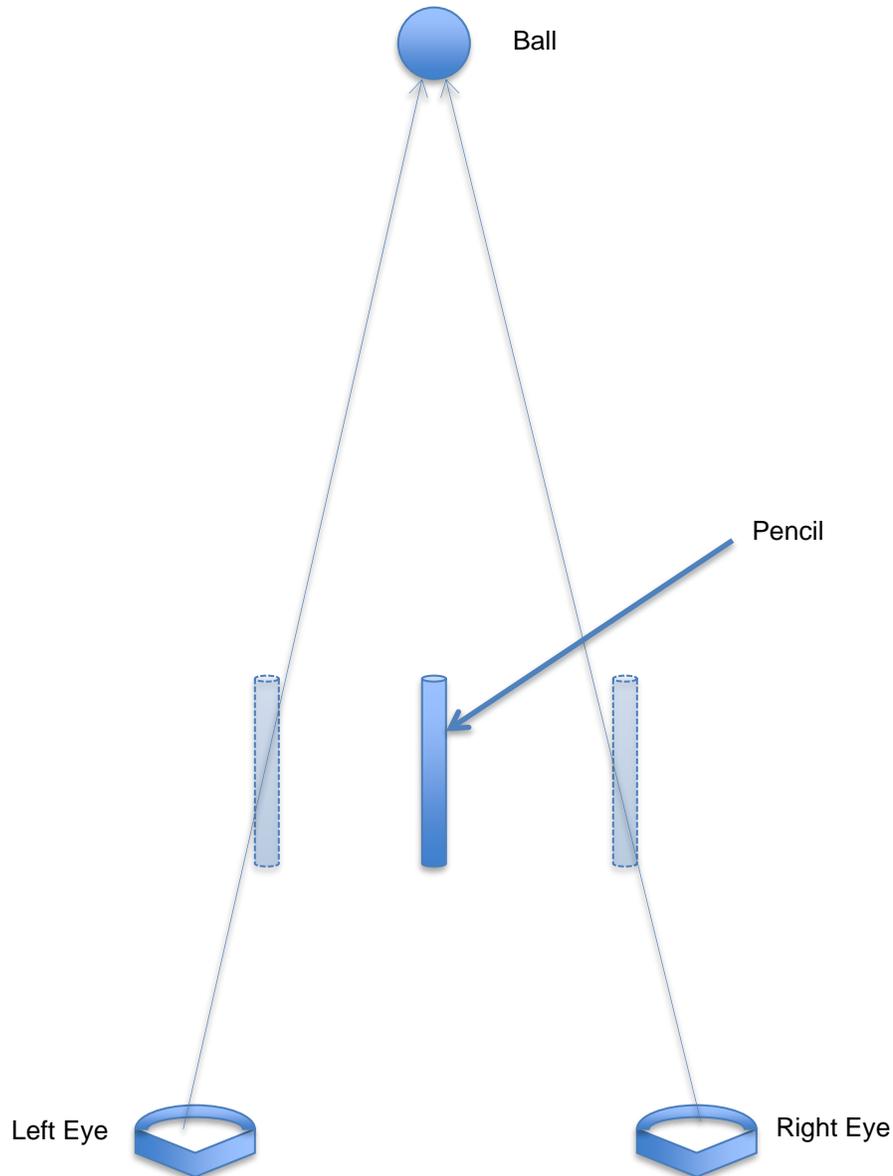
This extra layer of binocular difficulty would be a big barrier to sporting success in such a visually dependent sport like golf and is unlikely to occur in tour players.

Both methods (Fig 1 and Figs 2 and 3) demonstrate the effect of the change of fixation but No 1 is probably the easier way to understand what happens at the top of the swing when the club does not confuse the perception of movement. But equally it is important that golfers can see and understand this effect when holding the club and addressing the ball (Fig 2 and 3).

Eye dominance can have an effect on every aspect and every shot in the game even visualization of the flight of the ball and reading the green, particularly under pressure.

Fig 4 Physiological Diplopia

Looking at the ball on the floor hold a pencil vertically 12 inches from your nose. Observe two pencils, which appear either side of the ball.



### The Importance of Aiming

It can be seen from Fig 1 that an essential characteristic of true aiming is that the aiming eye (Right in Type 1) looks directly at the ball, eye position is fixed and stable. The vision in the left eye is offset to the left. This allows the left eye to calibrate depth by fine changes of focusing and eye position.

This microscopic variation in fixation in the non-dominant eye could explain a difference in the anatomy of the fovea of the non-dominant eye in binocularly stable subjects<sup>6</sup>.

It is interesting to note that a tendency to dyslexia may have the same origins in unstable eye dominance as this paper describes in golf. This is an example of the role sport has to play in understanding visual disability in other occupations including reading.

The fovea in these subjects is oval in shape (as opposed to circular in the dominant eye) implying an extended range of maximum sensitivity (an ability to search for optimum vision). It may be that far from being subservient to the dominant eye, which could be considered the workhorse of the visual system (the platform on which our perception of the world is based), it is the sensitivity of the non-dominant eye, which creates a picture of depth and subtlety separating the elite from the ordinary.

Once the optimum focus is established the displacement of the image in the left eye compared to the right eye gives the final judgement of depth. Without binocular (bi-foveal) vision depth cannot be judged accurately.

### The Effect of Non-Dominant Aiming (Type 1)

When the left eye is forced to take over the aiming task, the ball will appear to move to the left because the left eye is not in line with the shaft and clubface.

This is why too much effort maximising the backswing can cause difficulties for Type I. Excessive shoulder movement can force the head to turn away from the ball so the nose obscures the right eye. The player will not be particularly aware of this because they will still see the ball with the left eye but now its position has apparently changed.

When this happens at the top of the swing, the aim will be reprogrammed to what appears to be the new position of the ball. This means when the clubface comes down to strike the ball it will arrive earlier than expected; the clubface will be open and coming down on the ball.

For the average golfer this will result in a sliced shot with side and topspin, causing the flight of the ball to veer off to the right with reduced elevation.

With top level or tour players it could have the opposite effect causing hooks and push shots due to over-compensating for the misleading ball position. This is not a technical fault but what happens when the brain has to guess the position and distance of the ball on the tee.

### Limitations of Swing

Understanding the limitations of the swing in Type I may explain why the majority of the top golfers are Type II. In Type II, the left eye will always have a clear view of the ball, no matter how far back the swing goes. This means that the clubface can potentially achieve a higher velocity at the point of impact.

It is not the limitations on back swing that causes the problems with Type I; it is the interruption of binocular vision that happens when trying to emulate the swing of a Type II player. Despite being in the minority there are still great Type I players on the tour. These players can be recognised by the characteristic of a shorter backswing. They are likely to compensate for the reduced swing by an increased rate of acceleration into the ball (See Figs 5 Mark Hensby showing right eye cone alignment and Fig 6 Gregory Field proper head motion). Contrast this with too much head turn causing loss of dominant eye vision (See Fig 7).

Fig 5 Mark Hensby showing Right Cone Alignment



Fig 6 PGA Professional Gregory Field Texas Tech Proper Head Motion



Fig 7 Typical Right Eye Dominant Breakdown at the Top of the Swing to Avoid Losing Dominant Eye Focus



## Type II Does Not Have it All Their Own Way

The Type II player also has residual difficulties to cope with. To achieve the maximum swing they may be forced to turn their head, which means their nose could obscure their non-dominant right eye. When this happens they will lose depth perception making it more difficult to judge the distance of the ball at the end of the club.

In addition, the aiming eye and clubface are not perfectly in alignment (see Fig 3) where the aiming eye is now on a different side to which the club is held in a right-handed player. This means in Type II the ball appears consistently further to the left than it does to right eye dominant players who are right handed.

For the Type II player this positional inaccuracy is constant so apart from the danger of loss of bi-foveal fixation (depth perception) at the top of the swing, the player can adapt the position of their clubface or stance by experience. This does add to the complexity of the drive and makes it potentially less reliable as it does in any aiming sport when the sight picture cannot be relied on.

If the Type I player is able to limit the extent of the swing and maintain bi-foveal fixation, what they lack in distance could be more than compensated for by accuracy and consistency. It is possible that greater confidence would allow more strength and acceleration to be built into the shorter swing.

## Visual Correction

And finally it is also important to make sure that there is no other optical and correctable reason for instability of loss of focus, which will have a similar destabilising effect on aim and depth judgement, for instance:

- A muscle imbalance (weak muscle), horizontal or vertical
- A difficulty focusing in the dominant eye
- Prescription worse in the dominant eye
- All of which applies to the non-dominant eye because of its additional sensitivity and role in depth perception

Ideally, the player would have his or her coach working in partnership with a Sportvision specialist to make sure there is no visual impediment to the ability to compete. Players have an intuitive understanding of the importance of vision so the optometrist can be a powerful ally to the coach in supporting their training and coaching methods.

## Conclusion

The coming together of optical principles and coaching experience could be transformative for the game of golf. The understanding of what happens if there is a change of visual perception in the brain during the swing is key. In the context of the golf swing the resultant motor anomalies (the way all the muscles of the body work together) due to the loss of ball position and depth perception has never been fully understood.

It can lead to endless hours practicing which simply reinforces the fault and leaves a swing, which is little more than a best guess. Golf is one of the most visually demanding sports and understanding the importance of eye dominance could answer the frustrations of many players including perhaps the majority of club players.

## Authors

Richard Hughes, Dip Sport Vision, Dip School Vision, FASvP FAOI  
Works in general optometric practice and for the past 15 years has concentrated on sports and school vision. Past examiner for PQE prior to registration in DIT Dublin. Holder of the ASvP award for outstanding contribution to School and Sportvision Practice. Has presented at conferences on sports; hurling, golf and children with binocular vision problems.  
Contact [richughes59@gmail.com](mailto:richughes59@gmail.com) 00353872518465

Geraint Griffiths BSc Mech Eng, MSc. Optometry MASvP MCOptom  
MD and founder of Sportvision UK, Chair The Association of Sport and Schoolvision Practitioners (ASvP), Team leader and organiser of 23 international and national sport vision screenings, 40 publications in optical and sports journals. Author of the Diplomas in Sport and Schoolvision, Over 40 years in general practice and 27 years interested and researching Sportvision. Former examiner for the College of Optometrists specialising in binocular vision, Sportvision expert to the British Standards Institute, Former British International High jumper, Welsh and British Masters record holder  
Contact [Geraint@sportvision.co.uk](mailto:Geraint@sportvision.co.uk) +44 1162363113

Jim Hartnett has been a US PGA Professional for more than 25 years. He worked with all levels of players including many tour players from around the world. He worked at several top facilities including PGA West, Kapalua, and Sahalee Country Club and also worked for Jim McLean. He published two books most recently "Golf for the other 80%" and is working with two doctors to finish the third book, Anatomy of the golf swing.  
Contact: [jimh@pga.com](mailto:jimh@pga.com) 01-760-289-2879

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### Key words:

Eye Dominance, Aiming in Golf, Backswing Peripheral Awareness, Cone of vision, Foveal Anatomy, Vision Correction, Maxwell Spot Centroids, Dyslexia