Measurement of Eye Dominance
A Comparison of Methods
Paula McElduff

Introduction

Dominance is defined as a preference for one member of a bilateral pair of structures over the other when performing various activities. However, despite the fact that consistent ocular dominance has been observed in several studies, opinions differ on what it is and how to test for it. A number of different definitions exist, the most common are:

Sighting Dominance: The eye that is preferred when only one eye can be used (Coren, 1999). It most resembles the lateral dominance of hand and foot.

Sensory Dominance: The eye with the greatest input. It is demonstrated using binocular rivalry tests (Collins and Blackwell, 1974).

Clarity Dominance: The eye that provides an image that is perceptually clearer and more intense (Pascal, 1926).

Motor Dominance: The eye that has greater motor strength.

Acuity Dominance: The eye with the better acuity.

Thus, ocular dominance comprises many elements of visual skill, which makes it difficult to select methods to test for it.

Clinical Significance of Ocular Dominance

The determination of ocular dominance is believed to be of practical value in clinical examination and treatment. For example in monovision when correcting presbyopic patients and in sports vision, where eye, hand and foot dominance may have an impact on performance.

Self-Assessment of Ocular Dominance

Most individuals are in no doubt as to whether they are predominantly right or left handed and the same is usually true for foot preference. However, individuals are less aware of eye preference, probably due to the fact that in the majority of situations both eyes are open, even when information from only one eye is being used.
Aim of the Investigation

To compare tests used to determine ocular dominance and recommend a possible test that can be used in clinical practice.

Method

From the literature review 9 tests of eye dominance were selected that could be carried out in a clinical situation. Each subject was also asked to fill in a self-assessment questionnaire. 20 Caucasian subjects (10 male, 10 female) between 19-23 years were selected at random. The purpose of the investigation was not revealed until the end of the experiment to try to avoid any bias being introduced. Each of the tests was carried out twice to check repeatability.

The Questionnaire:
Each subject was asked to write their name, age and sex on a piece of paper. They were also asked which eye they felt was their dominant eye - right, left, mixed or don’t know.

The Tests:

1. **Head Tilt** (Berman, 1973): Each subject was observed while completing the self-assessment questionnaire. If a head tilt was seen, the opposite eye was recorded as dominant.

2. **Eye used to Align** (Pascal, 1926): The subject is asked to line up a pencil with a vertical target on the wall keeping both eyes open. Each eye is occluded in turn and the eye that keeps the pencil aligned is recorded as dominant.

3. **Cone** (Miles, 1930 in Porac and Coren, 1976): The subject covers his/her face with the wide end of a cardboard cone that is held with both hands. The subject is asked to look at a target that is seen through the smaller end of the cone. Each eye is occluded in turn and the eye covered when the target disappears is recorded as dominant.

4. **Winking** (Porac and Coren, 1976): Each subject was asked to wink. The eye that is more difficult to wink and therefore the one that is not winked, is the dominant eye.

5. **Variable Angle Mirror** (Bjork, 1980): The VAM consists of 2 plane mirrors moveably fixed to one another. The subject looks straight ahead at the reflection of his/her face in the mirror. The angle between the two halves of the mirror is increased initially to approx. 170 degrees and then slowly further until the hinge of the mirror covers one eye. This eye is the dominant eye. In addition, by increasing the angle so that one side of the face is compressed a further check of eye dominance is obtained. The side of the face that is compressed contains the dominant eye.
6. **Hole in the Card** (Rymar et al. 1984): The subject holds a 50x50cm card with both hands and views a target through the 4cm hole in the centre of the card. The eye used to view the target is dominant.

7. **Pointing** (Porac and Coren, 1976): With hands clasped together and index fingers pointing outwards the subject points at the examiner’s forehead. The eye that the hands are located in front of is recorded as dominant.

8. **Hole in Hand** (Robison et al. 1999): The subject's arms are fully extended and his/her palms placed together facing away. A small opening about the size of a 10p piece is made between the junctions of the thumbs and forefingers. The subject views the target through the opening with both eyes open. The eyes are alternately covered and the eye that is covered when the target disappears is dominant.

9. **Wand** (Robison et al. 1999): The wand is 25 cm long, with a handle at one end and a 5cm-diameter ring at the other end. The subject holds the wand with both hands and fully extends his/her arms, looking through the aperture of the ring with both eyes open, at the examiner’s left eye. This is repeated for viewing the examiner’s right eye, then forehead. The eye that the wand is positioned in front of is recorded as dominant each time.

### Results and Analysis

#### Analysis of Ocular Dominance Tests

1. **Head Tilt** This test was 85% repeatable and thus produces fairly consistent results. It was at times hard to observe as the degree of tilting varied. There is also a possibility of no head tilt and thus a result for dominance may not be obtainable. Hence, it is not a good test to determine eye dominance in all individuals.

2. **Eye used to Align** This test has the advantage that it is an unconscious sighting test. The subject believes that he is operating with full binocular vision and thus is unaware of selecting an eye to sight with. However, as the subject holds the pen with one hand, there is a possibility that the eye chosen is influenced by the hand used. Some subjects found this test difficult to understand, many initially tried to use one eye rather than both.

3. **Cone** In this test one’s subjective experience is that the alignment is being performed by placing the cone midway between the two eyes. Hence, it is an unconscious sighting test but it also has the added advantage that it controls for handedness (the cone is held in front of both eyes using both hands). This test is quick and easy to carry out, inexpensive in construction, and simple to understand. Furthermore is produces consistent results as it was found 100% repeatable.

4. **Winking** The eye not winked was recorded on the assumption that the dominant eye is more difficult to wink. However, it could be argued that the eye winked is the dominant eye on the basis that the muscles of the dominant eye are stronger and more efficient and thus easier to wink.
There is a high possibility of observer error with this test, as winking only takes a second and the eye winked is observed, yet the eye not winked is recorded. On comparison of the distribution of eye dominance found with the winking test to that of the other tests, it is apparent that there is a completely different pattern. 55% of subjects were reported left eye dominant compared to the other tests which found a greater proportion of right eye dominance. If the eye winked had been taken as the dominant eye, a finding more in keeping with the rest of the tests would have been obtained.

Even if winking could be proved a valid test for eye dominance, difficulties would arise as some individuals cannot wink, while others can wink with either eye.

5. **Variable Angle Mirror**  The advantage of the VAM is that subjects are ignorant of its purpose and unlike a sighting test there is no possibility of having been trained to use a particular eye in a similar circumstance. Also it was found 100% repeatable. However the test is difficult for the subject to understand and thus is time consuming as considerable explanation and instruction is often required. Furthermore, it is more expensive and hardest of all the tests to construct.

6. **Hole in the Card**  This is a conscious monocular sighting test, forcing a selection of one eye. Therefore results may be contaminated by the fact that the subject knows that only one eye will be used. However, it was found 85% repeatable and has the advantage that it is not influenced by handedness (the subject holds the card with both hands), it is easy to understand and simple to perform.

7. **Pointing**  This test is an unconscious sighting test that requires the examiner to determine the dominant eye from the position of the hands in front of the eyes. It does not force a choice of one eye as the hands can be positioned between the eyes indicating mixed dominance. However, the option of mixed dominance raises the question of the differentiating capacity of the method. Although it may be argued that some individuals do not have a dominant eye and thus other tests are less sensitive as they are unable to detect this. Even though both hands are used in this test the factor of handedness is not entirely eliminated as there is a possibility that the dominant hand may influence their position in front of the eyes.

8. **Hole in Hand**  This test is an unconscious sighting test and although it may be considered a fairly accurate test of eye dominance (80% repeatable) there is a possibility of contamination from using the hands. Furthermore the size of the hole made by each subject is variable and cannot be controlled.

9. **Wand**  This test is similar to the pointing test as the examiner assesses the position of the aperture in front of the eyes and there are three possible responses: R, L or Mixed. Although it is an unconscious sighting test, it is was found that some subjects just positioned the aperture in front of the eye they were looking at rather than using any particular eye to sight the target. This lack of understanding of the test is reflected in the poor consistency of the results obtained, the test was only 65% repeatable. Furthermore handedness may have affected the results.
Analysis of Ocular Dominance

The result of each test was recorded as Right (R), Left (L) or Mixed (M). These results were then converted into a score: +1 for R, -1 for L and 0 for Mixed. These scores (2 for each test) were then totalled to produce an overall score. The maximum score possible was +18 and the minimum score -18 and the scores were classified as follows:
Greater than 6: Right Dominance
-6 to 6: Mixed Dominance
Less than -6: Left Dominance

Dominance scores for each subject

<table>
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<tr>
<th>Subject</th>
<th>Sex</th>
<th>R Scores (+)</th>
<th>L scores (-)</th>
<th>Mixed Scores (0)</th>
<th>Total score</th>
<th>Ocular Dominance</th>
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<td>0 (x3)</td>
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Percentage Distribution of Ocular Dominance in the Sample

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<tr>
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<th>Overall (n=20)</th>
<th>Male (n=10)</th>
<th>Female (n=10)</th>
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<tr>
<td>Right</td>
<td>55%</td>
<td>40%</td>
<td>70%</td>
</tr>
<tr>
<td>Left</td>
<td>30%</td>
<td>40%</td>
<td>20%</td>
</tr>
<tr>
<td>Mixed</td>
<td>15%</td>
<td>20%</td>
<td>10%</td>
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</table>
Sex Differences in Ocular Dominance

70% of females in the sample were R eyed dominant compared to only 40% of males. There was an equal percentage of R and L eye dominance and a higher proportion of mixed dominance in the male sample compared to the females.

Analysis of Self-Assessment Scores Versus Actual Scores for Dominance

20% of the sample could not estimate their eye dominance indicating that there may be a significant proportion of the population that are unaware of possessing a dominant eye. 25% of the sample was incorrect in the assessment of their eye dominance.

Discussion and Evaluation

Ocular Dominance Tests

The majority of the eye tests, with the exception of winking, reported more right than left eyed individuals in the sample. Thus it could be suggested that these tests, bar winking, are measuring a common property but some more efficiently than others. The fact that some tests had the option of mixed dominance (i.e. head tilt, pointing and wand) may account for some of the differences among the results recorded.

Sighting Tests

In general, it was found that sighting tests are more accurate and consistent indicators of ocular dominance than non-sighting tests. This finding is supported by Porac and Coren (1976) who reported that sighting dominance is the most commonly measured form of eye dominance and appears to be the most reliably obtained.

The Cone Test appears a useful test as it is an unconscious sighting test and is repeatable, simple to construct and easy to perform. The Wand is the only sighting test whose use would be questioned, due to the fact that it is difficult to understand and it has a low repeatability. Also, it is not widely used, and was only found in one study reviewed (Robison et al. 1999.)

The remainder of the sighting tests have been widely used in many investigations (Oddy and Lobstein, 1972; Ibi 1996; Porac and Coren, 1975; Rymar et al., 1984; Berman, 1973 and Gronwall and Sampson, 1971) indicating that they are generally considered good tests of ocular dominance. The review of the tests supports the assumption by Crider (1944) that unconscious monocular sighting is the best determinant for ocular dominance (Pointer, 2001).

Non-Sighting Tests

The findings of this study do not support the use of non-sighting tests. The review of the head tilt test found that it is not a good test for determining eye dominance despite there being an argument (Porac and Coren, 1976) to support its use.
In agreement with Fink (1938) winking was found to be a very poor and unreliable test of ocular dominance. Although the VAM test (Bjork, 1980) was 100% repeatable, it was not found used or mentioned in any other literature reviewed in this study. Also, it was more difficult to construct and explain than the other tests.

Lateral Dominance

The distribution of eye dominance found is reasonably consistent with that of previous studies, most notably Coren and Kaplan (1973) who reported 62% right eyed, 28% left eyed and 10% mixed and Groden (1969) who reported 53% right eyed, 25% left eyed and 22% mixed. The percentage of the sample that was right eye dominant was much lower than I would expect for hand dominance (approx. 90% of the population is right handed, Porac, Coren and Duncan, 1980). This may be because the social pressure towards right sidedness is not as strong for the eye. However, in the case of sports such as rifle shooting where ipsilateral eye-hand dominance is an advantage, this pressure may be present. Thus a higher percentage of right eye dominance may be expected among this proportion of the population.

Self-Assessment Scores versus Actual Scores for Dominance:

From the results it is evident that self-reporting of eye dominance should not be used in place of tests for dominance.

Conclusion

Based on the particular adult population described, the following conclusion was reached:

There is no perfect test for eye dominance, however the cone test is recommended for use in clinical practice. Indeed any of the sighting tests, with the exception of the wand test would be suitable.

Further Investigation

The ocular dominance scores for each subject could have been used as a measure of the strength of their dominance and these results analysed. It could be investigated whether a battery of tests for ocular dominance is preferable to one test, as the strength of a person’s dominance could also be determined.

References