# VISUAL PERFORMANCE AND HOW IT RELATES TO ATHLETIC PERFORMANCE

*Craig E. Schachter*
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FERRIS STATE UNIVERSITY
COLLEGE OF OPTOMETRY

## Abstract

Athletes are consistently striving to reach their performance peak using methods from steroids to hypnotism. This paper concentrates on finding an aspect of the visual system that separates the superior athlete from the poorer athlete. The subject group must be one whose respective sport requires a high degree of visual abilities. For this reason, the Ferris State University womens varsity tennis team was chosen. Most of the tests used were selected on the basis that they had previously been shown to test visual skills that are significantly more efficient in superior athletes vs. lesser athletes and athletes vs. nonathletes. The visual skills tested were static distance acuities, distance heterophorias, near point of convergence, distance vergence facility, distance stereopsis, saccades, peripheral visual fields, and contrast sensitivity function. At the request of the tennis coach, the role of eye dominancy was investigated. If the data proves the hypothesis, this information can be used to develope a visual training program that may potentially enhance athletic performance.

## Introduction

Athletics at the college level and above are responsible for millions of dollars in revenue each year. Thus, athletes and coaches are consistently looking into areas that may improve the athlete's performance. One of the areas that more people are looking at, is the field of sports vision. Optometrists are not only providing vision care for athletes at the college, Olympic, and professional levels, but also at the recreational, Little League, and high school ranks.[1] The United States Olympic Committee has such high regard for the area of sports vision, that they have developed a vision performance and enhancement facility at the Olympic Training Center in Colorado Springs, Colorado.[2]

When attempting to find a correlation between visual performance and athletic performance, we must keep in mind these three assumptions provided by Stine, upon his review of the literature:

1) athletes have better visual abilities than nonathletes and that better athletes have better visual abilities than the poorer athlete.

2) visual abilities are trainable

3) visual training, of visual abilities, is transferable to the performance of the athlete.[3]

The basis for this paper depends on the fist two assumptions. Throughout the literature, studies have shown that the superior athlete posesses better visual skills in the areas of:

1) lower amounts of heterophoria at distance
2) closer near point of convergence
3) distance vergence facility
4) distance stereopsis
5) more accurate saccadic eye movements
6) larger peripheral visual field

The womens tennis team was selected for this study due to the fact that all of the visual skills previously mentioned are required for successful tennis play. The only group that may have a higher visual demand than a tennis player is a baseball player. However, the sport of tennis allows for a more direct evaluation of the better player to the lesser player. Whereas in baseball, the direct comparison of the overall abilities of a catcher to an outfielder is not as easy. By ranking each player at each visual skill tested, and utilizing the

player's seeding on the team, a direct comparison can be made.

The battery of tests were chosen based on the fact that they are mentioned in the literature as being required for good athletic performance. Except, in the case of contrast sensitivity function. No information was found relating it to athletic performance. Also influencing the selection of the testing, was the ease of administration at the Ferris State College of Optometry Clinic. The inclusion of eye dominancy and how it relates to preferred stroke(backhand or forehand) into this study was requested by the tennis coach. He had theorized that a right handed player who preferred a forehand shot might be left eye dominate, since that eye would have a better view of the ball. In other words a player who preferred a forehand shot would be crossed eye-hand dominate and a player who preferred a backhand shot would be uncrossed dominate.

The major goal of this project is to determine if certain visual skills can be singled out as being more effecient in a superior athlete vs. a lesser athlete, in a visually demanding sport such as tennis. Also, eye dominancy and it's role in tennis will be investigated.

## Methods

### Static visual acuity at distance:

Visual acuities were taken in a standard room with standard illumination. The need to see sharply and clearly in any sport goes without saying, especially in tennis where the ball creates enough blur just by the speed that it moves.

### Distance heterophoria

This measurement of the eye's alignment was done in a standard room with standard illumination. The target used was a single snellen letter one size larger than the visual acuity. The amount of heterophoria was determined using loose prisms according to the athlete's subjective response. In a study done by Grayiel et al, they reported significantly lower amounts of heterophoria, at distance, when comparing twenty-five champion tennis players to one hundred and ninety-four untrained students. [4]

### Near point of convergence (NPC)

The NPC was tested in a standard room with standard illumination. The target used was a 20/30 nearpoint letter. NPC was recorded as the distance from the corneal apex to the point at which the subject experienced diplopia, as the examiner moved the target closer. If no subjective diplopia was noted, the objective break of fusion was recorded. In a screening of fifty Little Leaguers aged eleven to thirteen, Falkowits and Mendel discovered a nearly linear correlation between NPC and batting averages. The closer the NPC, the higher the batting average of the subject. [5]

### Vergence facility at distance

Utilizing a 4BI and a 8BO loose prism, vergence facility was measured in a standard room with standard illumination. A single Snellen letter one size larger than the visual acuity was used as the target. The athlete was instructed to say "single" when the target became one, after prism insertion. The vergence facility was recorded as completed cycles in one minute. In a report comparing visual skills of athletes to nonathletes, the athletes significantly completed more cycles per minute than the nonathletes. [6]

## Distance stereopsis

This is the ability to judge not only how far away a ball or an opponent is but also how fast and in what direction it is moving. This was measured using the Howard-Dolman apparatus, with the subject at ten feet. The athlete was instructed to move the pegs to maximum disparity and then move them closer until they appeared to be straight across from each other. Four trials were run and these were used to determine stereopsis. Olson compared depth perception between varsity college athletes, intramural athletes, and nonathletes, using the Howard-Dolman apparatus. He found that the varsity athletes had better stereopsis than the intramural athletes, and the intramural athletes had better stereopsis than the nonathletes.[7]

## Saccadic eye movements at distance

Saccadic eye movements are quick, abrupt movements of the eye as it changes fixation from one point to another. The method for testing saccades was adopted from the method used by Christenson and Winkelstein.[8] Transparencies of the Developmental Eye Movement Test (DEM) were projected onto an overhead screen, with the projector and athlete at ten feet. The athlete was timed to the nearest tenth of a second on the two vertical tests and the one horizontal test. A ratio of the horizontal time to the vertical time was used to establish a standard score. Christenson and Winkelstein's study showed that saccades are better in athletes vs. nonathletes. Ralston, a former #1 ranked tennis player states, "Among the better players, you see less head movement. Good players invariably let thier eyes do the tracking of the ball much more than thier heads."[9]

## Peripheral visual fields

Good peripheral vision allows the athlete to maintain awareness of what is going on around them while being able to concentrate thier attention straight ahead. The extent of the athletes visual field was measured on a Topcon Bowl Perimeter, using a I4E target size. Measurements were taken of the horizontal and vertical limits. Rudini investigated athletes in eight sports and nonathletes and found that athletes had significantly larger peripheral fields.[10]

## Eye dominancy

As mentioned previously, the role of eye dominancy and it's role in tennis is being investigated at the request of the tennis coach. Eye dominancy was determined by having the examiner sit at the end of the exam room with one eye covered. The athlete was then instructed to use her dominate raquet hand (the hand used to hold the raquet during a forehand) and point at the examiner's uncovered eye. The examiner could then determine eye dominancy by how the subjects finger aligned with thier eyes. The athletes were classified as right eye dominate, left eye dominate, or mixed dominate. Mixed dominancy was determined if the athlete's finger was aligned at some point between the eyes. Drs. Portal and Romano found that members of the Florida State baseball team who were mixed dominate had an average batting average of .340, while players that were cross dominate (right eye and left hand dominate or left eye and right hand dominate) averaged .310 and players that were uncrossed dominate averaged .250.[11]

### Contrast sensitivity function (CSF)

Using the Vistech Consultants, Inc. wall chart, CSF was measured at a distance of ten feet. This was done in a standard room with standard illumination. Each eye was tested separately at five different spatial frequencies. Even though no literature exists, this area was investigated to search for additional visual skills that are related to athletic performance.

### Examiners

All examinations of the athletes were performed by the author. In order to eliminate any biased interpretations of the the results, the seedings of the athletes were unknown during the administration.

## Discussion

The following discussion will describe how each visual skill tested relates to the assumption that, superior visual skills exists in the superior athlete vs. the lesser athlete.

### Static visual acuity

As mentioned earlier, good visual acuity is essential for the sport of tennis. None of the athletes had a visual acuity of less than 20/20+1 monocularly and 20/15-2 binocularly. While these results do not seperate the superior player from the lesser player, they do indicate that maximum visual acuity is a must.

### Distance heterophoria

Results from this test ranged from measurements of 1 exophoria to 2 esophoria. The #4 player is strabismic and her results were disregarded during the evaluation. These insignificant findings contradicts Grayiel's report; however, it is not known if he measured the heterophorias objectively or subjectively. In Christenson and Winkelstein's study, they found no significant difference in heterophorias between athletes and nonathletes.[12] Once again, it is not known if their measurements were done objectively or subjectively.

### Near point of convergence (NPC)

All of the players had an NPC near three centimeters except the #6 and #8 players. Their NPC's measured 7.5cm and 5.5cm respectively. It is difficult to correlate these findings with level of athletic performance. However, it does appear that NPC is an important visual skill related to athletic performance in general. Further testing is indicated before any definite relationship can be identified.

### Vergence facility at distance

The testing of this visual skill appears to indicate a definite relationship to the superior and lesser athlete. The #4 player's results were not included in evaluation of this data. When looking at the graph, a steady decline in vergence facility is noted from the #2 player to the #7 player. These findings appear to be significant even though the #1 player's results equal the lowest found.

### Distance stereopsis

Again, the #4 player's data was not included in evaluation of this visual skill. Many reports exist supporting the theory that superior stereopsis is associated with the superior athlete, while just as many reports deny this. The data, from

this study, shows more support for the theory. If the first half of the team is compared to the second half of the team, the results are 5.5 seconds of arc to 13.3 seconds of arc. In the reports that disagree with the above theory, stereopsis was determined by methods other than with the Howard-Dolman apparatus.

### Saccadic eye movements at distance

Contrary to Christenson and Winkelstein's paper, no relationship between saccades and level of athletic performance was found. In their testing, they measured saccades according to a time to complete a task. This study utilized a ratio comparing horizontal reading time to vertical reading time. By using the ratio, this eliminates any contamination from the subject being a fast talker or reader, thus, being a better indication of pure saccadic eye movements. Good eye movements are obviously necessary for tennis play, as a result, further testing should be done before definite conclusions can be made.

### Peripheral visual fields

The results from analysis of this visual skill show no significant correlation separating athletes by their level of performance. Recently, studies have indicated significant results between athletes and nonathletes when testing peripheral recognition.[13] Additional testing needs to be performed to determine validity.
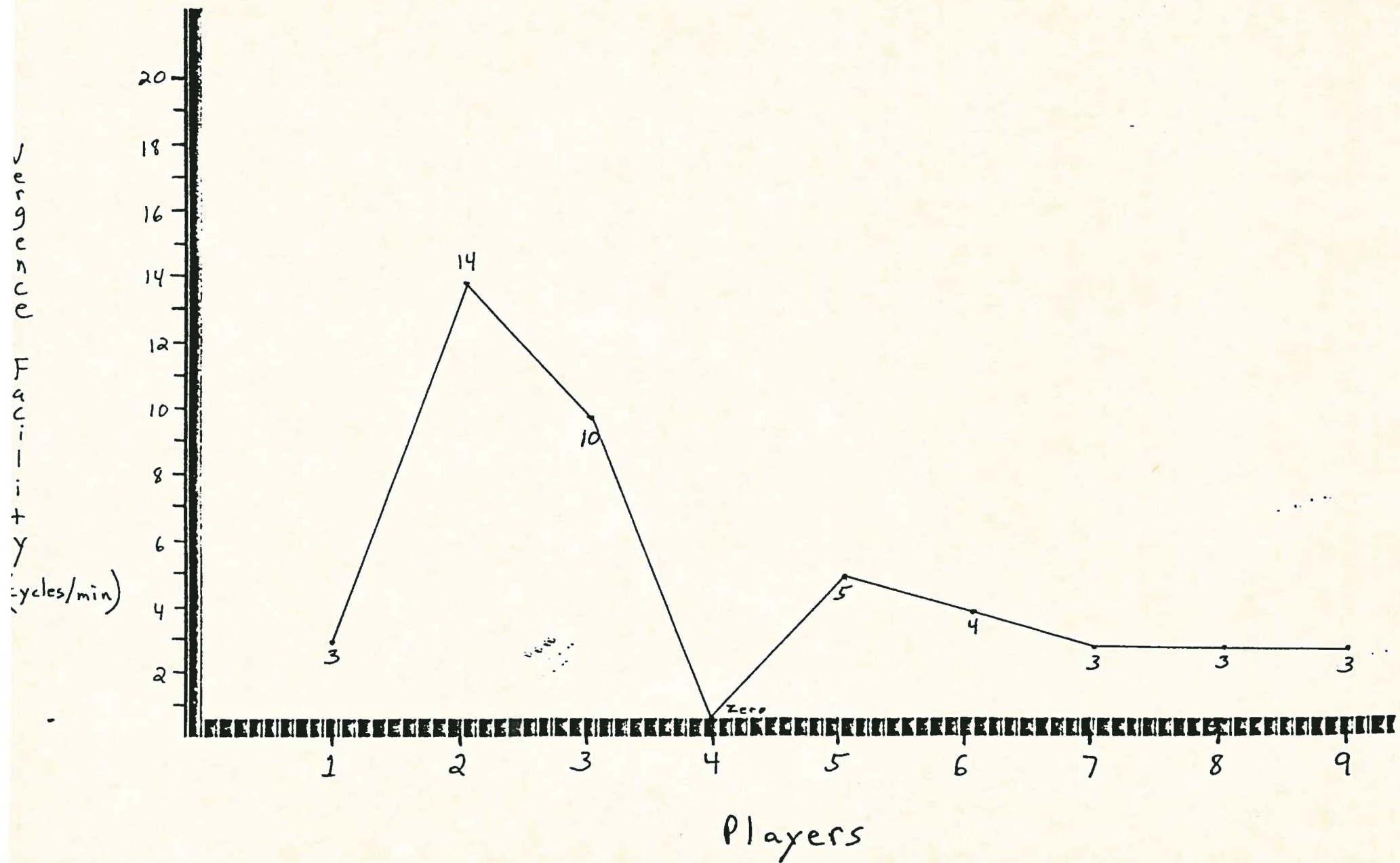
### Eye dominancy

These findings strongly agree with Portal and Romano's study. The results are as follows: #1-mixed, #2-mixed, #3-crossed, #5-crossed, #6-uncrossed, #7-mixed, #8-uncrossed, #9-uncrossed. While eye dominancy is an inherited trait, thus untrainable, it could prove useful when "tailoring" a player's game to them. It should be noted that, as a result of her strabismus, player #4's results were not included in the evaluation.

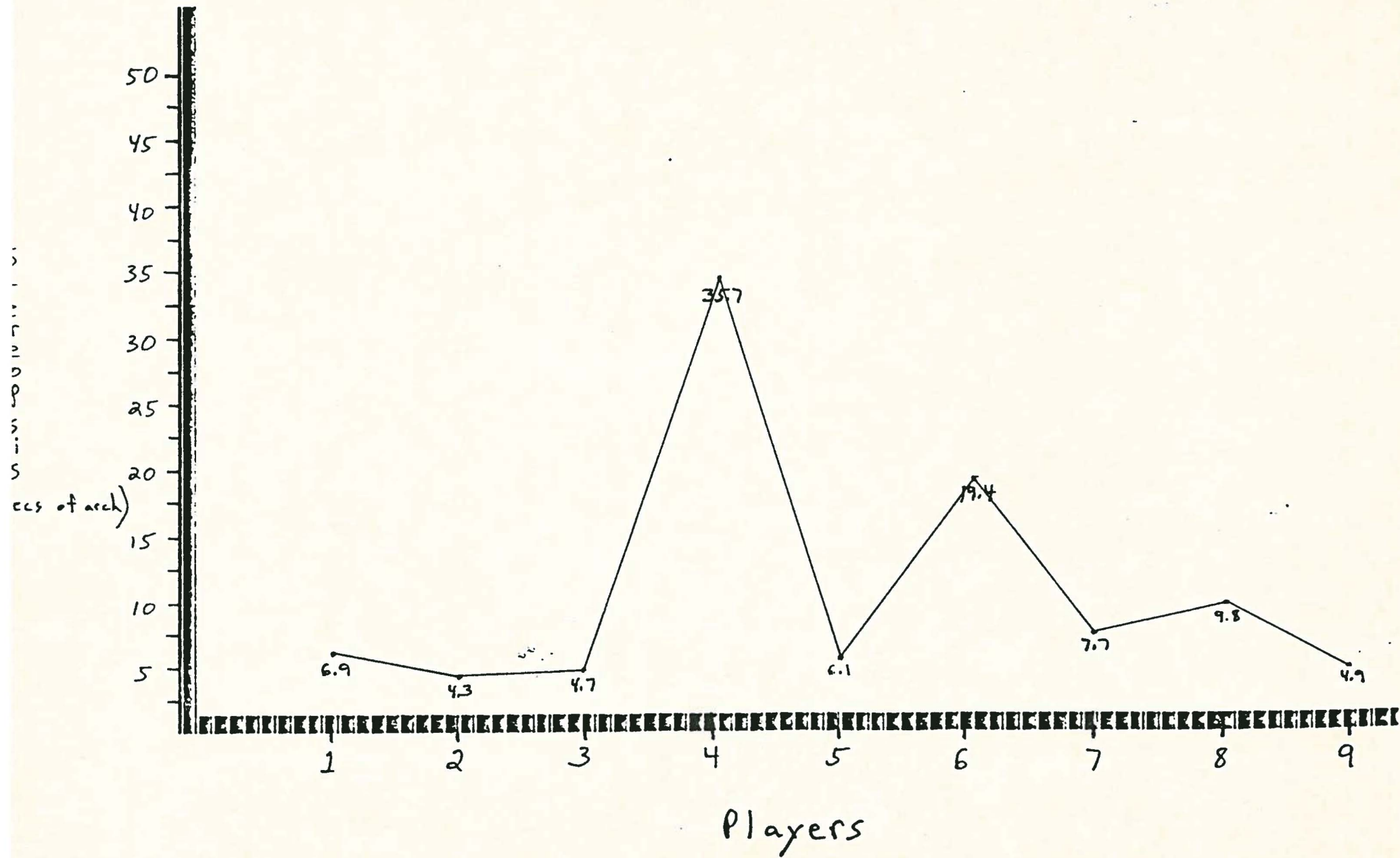### Contrast Sensitivity Function (CSF)

Results, from testing of this visual skill, reveals no significant data. All athletes tested at the upper end of normal or above normal. Additional research in this area may include binocular testing and testing on a computerized CSF instrument.
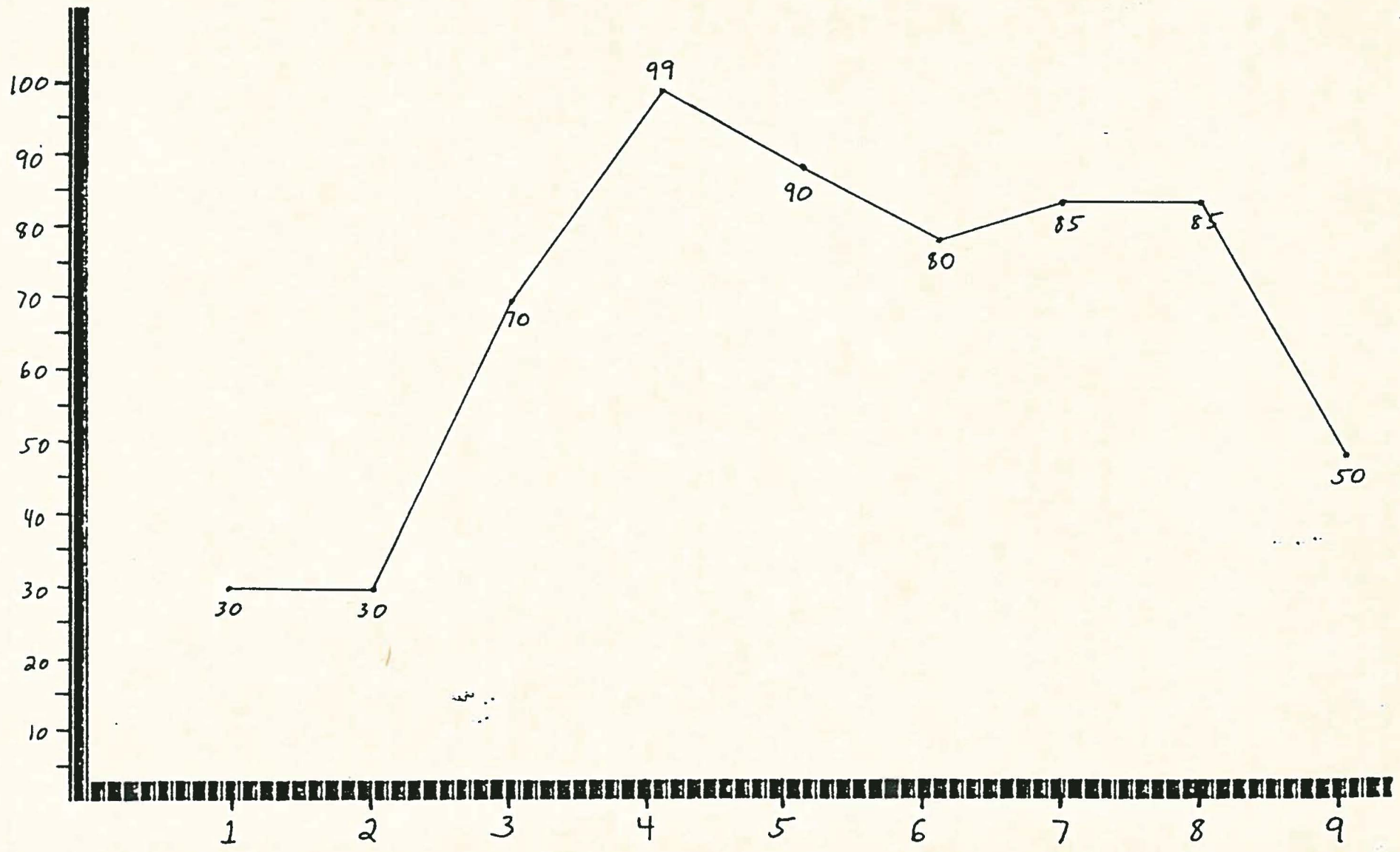
### Conclusion

As a result of this study and others before it, there is significant proof that certain visual skills are superior in the superior athlete. These include vergence facility at distance, distance stereopsis, and characteristics of eye dominancy. There are also areas that need further evaluation before definite conclusions can be made. However, by properly utilizing information from this study and others, an effective sports vision program can be develped to help an athlete reach his performance peak.

Vergence Facility (cycles/min) vs Players

20, 18, 16, 14, 12, 10, 8, 6, 4, 2

Players: 1 (3), 2 (14), 3 (10), 4 (zero), 5 (5), 6 (4), 7 (3), 8 (3), 9 (3)

50 —
45 —
40 —
35 —
30 —
25 —
20 —
15 —
10 —
5 —

ccs of arch)

35.7
19.4
9.8
7.7
6.9
4.3
4.7
6.1
4.7

1    2    3    4    5    6    7    8    9

Players

Players

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