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Jill M. Hlavac
Pacific University

Michael W. Stoner
Pacific University

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Abstract

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Committee Chair

Bradley Coffey, O.D.

Second Advisor

Alan W. Reichow, O.D.

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THE OCCURRENCE PATTERNS OF EYE-HAND PREFERENCE IN ATHLETES AND NON-ATHLETES

By

JILL M. HLAVAC

AND

MICHAEL W. STONER

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Advisors:

Bradley Coffey, O.D.
Alan W. Reichow, O.D.

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APPLICANTS

Jill M. Hlavac — 5/15/91 Date

Michael W. Stoner — 5/13/91 Date

ADVISORS

Bradley Coffey, O.D. — 05/15/91 Date

Alan W. Reichow, O.D. — 5-10-91 Date

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BIOGRAPHICAL SKETCH

Jill M. Hlavac

I graduated from Kearney State College in Kearney, Nebraska in August 1986 with a Bachelor of Science degree in Comprehensive Mathematics. I entered the University of Houston College of Optometry in August 1986 and transferred to Pacific University College of Optometry in August 1987. After graduating from Pacific University College of Optometry in May 1991, I will continue my schooling in the Education Department at Pacific University with expected graduation in August 1991 with a Masters degree in Education - Visual Function in Learning. Upon graduation, I intend to return to the Midwest region to practice behavioral optometry. My interests are in the areas of vision therapy, pediatric optometry and the special needs of multiply-handicapped children.

I am currently a student member of the American Optometric Association, AOA Sports Vision Section, AOA Contact Lens Section, College of Vision Development, Optometric Extension Program, and Colorado Optometric Association. My future plans include becoming a Fellow in the College of Vision Development, and establishing a multidisciplinary practice to accommodate children with learning problems related to vision.

BIOGRAPHICAL SKETCH

Michael W. Stoner

I attended California State University at Northridge. In August 1988, I entered Pacific University College of Optometry and my expected date of graduation is May 1992. While attending optometry school I completed my Bachelor of Science degree in Visual Science in December 1990. I have coached the men's tennis team at Pacific University during the 1990 and 1991 seasons. After graduating from Pacific University College of Optometry my wife, Kelly, our daughter, Whitney, and I will stay in the West Coastal Region and I will practice full-scope optometry with an emphasis in the visual needs of children.

I am currently a student member of the American Optometric Association, AOA Sports Vision Section, College of Vision Development, and Optometric Extension Program.

ABSTRACT

Eye and hand preferences were determined for 268 elite athletes and 90 non-athletes to determine occurrence patterns. Comparisons were made between athletes and nonathletes to evaluate patterns of ocular preference, hand preference and tendencies for homolateral or crossed preference. No significant differences were found for ocular or hand preferences in athletes versus nonathletes. Similarly, no significant differences were shown for homolateral or crossed preferences. Recommendations for standardizaton of evaluation technique related to eye and hand preferences are discussed.

INTRODUCTION

Throughout the years, there has been continuing interest from various professions concerning the relationship of eye-hand preferences and the effects on school or sports performance. Questions have arisen as to whether ocular and hand preferences do in fact exist, and if so, how they may be determined. Confusion has resulted due to differing terminology and nonstandard testing for both ocular preference and hand preference. There is still uncertainty if established preferences are stable or if they can differ between tasks or throughout life.

In addressing these issues, one must consider cerebral dominance and how it affects laterality. The "dominant" cerebral hemisphere[1,2] is considered by some to be the left hemisphere because of its function in language: speech, writing, identifying by name, and comprehension of written and spoken language are all considered to be associated with left hemisphere brain function. The "nondominant" right hemisphere is responsible for such tasks as visual-spatial relations and tactile interpretations. Both hemispheres have motor fibers that control movement on the contralateral side of the body. The "dominant" hemisphere has also been identified as the one dictating lateral preference, or "sidedness"[3,4] (ie. left cerebral hemisphere, right hand preference). Delacato[3] suggested that the establishment of cerebral hemisphere dominance is dictated by genetics (ie right-sided parents are apt to have right-sided children; however, right-sided parents who have a genetic bias toward twinning are more apt to have left-sided children). It has also been argued that because visual sensory fibers are sent to both cerebral hemispheres, there can be no ocular preference[5]; and likewise, there is no obvious physiological reason for a correlation between limb and ocular preference.[6,7,8]

As movement is a motor function of the contralateral hemisphere, it might be expected that both limbs of the same side would be preferred. It has not yet been determined whether sidedness is determined at birth. Stern[7] stated that 25% of any large group is born right-handed, 25% left-handed and 50% are ambidextrous, but later follow the trend of a right-handed culture. Delacato[3] suggested that although there is a genetic bias for hand choice, resultant hand preference is learned and reinforced by consistent use. Right hand preferences have been found in 60-91% of the general population.[8,9]

These variations may be attributed to differences in testing methods. Wold[5] listed 50 testing methods utilized in ten studies to determine hand preference. The methods most commonly used included cutting with a knife or scissors, throwing an object, eating with a spoon, writing, and threading a needle. Other methods included turning a door knob, playing tennis, and grasping. Wold referenced reports that 4-20% of learning disabled populations were left-handed. This suggests that left hand preference may be related to learning disabilities, but it is important to first consider ocular preference and combined eye/hand preference.

Ocular preference, also termed ocular dominance, eye dominance, and preferred sighting eye, refers to the eye used in monocular sighting tasks, such as viewing through a telescope or sighting down a rifle. Wold[5] listed 29 methods of determining sighting preference, including looking through a tube, hole-in-card, or into a kaleidoscope, comparing facial asymmetry, winking reflex, and visual acuity. Several studies[9,10,11,12] which determined distance ocular preference reported 57-70% of normal populations have right eye preference. Wold[5], in his study of a learning disabled population, found preferred eye at distance was the same as the preferred eye at near in 72.4% of subjects. He theorized these differences were a consequence of the demand level of the test. For example, distance sighting is a low level acuity test and is based on peripheral sighting, whereas near tasks such as reading require a higher level of cognitive functioning which might cause a switch in the preferred eye for the task.

Besides the preferred sighting eye, Walls[4] discussed a second type of ocular dominance that occurs under binocular or monocular conditions and is used in the establishment of the perceived egocentric directions of visual objects. He refers to it as "motor ocular dominance." Other names similar to this type of ocular preference have been "ocular motor dominance,"[13,14] "controlling eye,"[5,6] and "referent eye."[15]

Studies of the controlling eye utilized the Dunlop test[13] to determine the controlling eye. A synoptophore and slides were used to perform the Dunlop test. The tubes of the synoptophore were first adjusted so that the slides were fused. Then the tubes were separated such that the subject's eyes diverged until movement was perceived. The eye that detected the movement was determined to be the controlling eye. If the controlling eye was found to be the same in eight or more of ten trials, it was said to be stable; it was otherwise

referred to as unstable. This becomes important in comparing homolateral and crossed eye-hand preferences.

Homolateral preference refers to the condition in which the preferred eye and hand are on the same side, such as right eye, right hand. Crossed preference means the preferred eye and hand are on opposite sides (eg. right eye, left hand). Several studies[5,9,11,16,17,18] of normal samples have found crossed preference incidence to be 18-35%. Wold[5] reported 24.8% of a learning disabled sample exhibited crossed preference at distance and 20.8% at near. Notable differences were found when the controlling eye was compared with the preferred hand. Several studies[4,5,6,13,14,15] of learning disabled samples found that subjects with crossed control exhibited the most problems in performance, despite homolateral or crossed monocular preference. An example of crossed control would be right hand preference and left eye control regardless of left or right eye preference during monocular sighting tasks. Not only were problems detected in subjects with crossed control, but they were also evident in subjects with unstable control.

There is scant published research comparing eye and hand preferences in athletes. Shapiro and Kropp[17,18] studied the relationship of eye-hand preference in archery, shotgun, pistol, and rifle sports. No statistical analysis was given but, they found that crossed preference was present in 27% of their sample of 427 amateur recreational shooters. In comparing the individual sports they found that almost all pistol shooters preferred to shoot with one eye closed. Those with right homolateral preference shot with the left eye closed. Left handers used their dominant eyes for aiming and one subject with right hand and left eye preferences used the right eye for aiming. The majority of riflemen preferred to shoot with both eyes open using homolateral preference for aiming. The majority of subjects participating in shotgun exhibited homolateral preference and were unable to shoot with both eyes open. Archers with homolateral preference shot with both eyes open and those with crossed preference closed the non-aiming eye. Shapiro and Kropp suggested that if homolateral preference determined by the preferred sighting eye was used in aiming, performance might be improved .

Sheeran[19], in a 1985 study of 34 right-handed male cadets in the Reserve Officers Training Corps, found that in the early stages of training, those subjects with homolateral preference were better marksmen than those with crossed preference ($p<0.05$). The article also mentioned that training was

determined by hand preference, meaning, if the subject preferred the right hand, they were trained using the right hand regardless of eye preference. Sheeran also suggested the possibility of better performance with training based on eye preference rather than hand preference.

In their widely-cited 1988 study, Portal and Romano[16] compared eye/hand preference between 78 baseball players and 91 normal controls. No specification of the normal controls were identified with respect to participation in any sports activity. Their findings showed twice as many crossed preference baseball players (35%) than in the normal controls (18%) ($p<0.01$). Batting averages were better for those crossed preference athletes, 0.310 compared to 0.250 for batters with homolateral preference.

Fremion, et al[11] reported that 61% of tennis players (N=51) have right eye preference compared to 57% of age-matched controls (N=49) with right eye preference. Thirty-seven percent of tennis players showed crossed preference compared to 43 percent of the controls. However, neither of these comparisons showed a significant difference.

These studies hint that there may be a correlation between eye and hand preferences and sports abilities. The current study evaluates that possibility through comparison of eye/hand preference patterns in samples of athletes and non-athletes.

METHODS

The subjects were young adult elite athletes from the United States who were invited by the United States Olympic Committee to participate in the 1985 National Sports Festival in Baton Rouge, LA and the 1986 United States Olympic Festival in Houston, TX. Data for 268 athletes were obtained. The total sample consisted of 196 men (73.13%) and 72 women (26.87%). The sports represented in the sample include volleyball, team handball, soccer, baseball, field hockey, ice hockey, table tennis, all the Olympic shooting disciplines, and archery. Athletes who used spectacles or contact lenses during competition were tested while wearing their habitual lenses. All other athletes were tested with no lenses in place.[20]

The nonathlete subjects were 90 optometric students and spouses who did not participate in athletic activities more than once a week. There were 62 male (69%) and 28 female (31%) subjects.

Data for sighting eye preference were obtained using either the hand-over-hand or the hole-in-the-card methods. Eye preferences for the non-athlete sample were determined using the hand-over-hand method of arms extended downward in front of the subject, thumbs crossed with the fingers of one hand overlapping those of the other hand. The subjects were instructed to raise the extended arms and sight a distant object through the hole formed between the thumbs and fingers of the two hands. The eye with which the subject could still see the sighted object when the other eye was occluded was determined to be the preferred eye. Two trials were run, one with right hand over left and one with left over right. A third trial was run if the first two trials were not inagreement.

Eye preferences for the athletic population were determined using the hole-in-the-card method. The subject held a 4.5'' X 5.25'' card with both hands, arms extended downward. When instructed, the subject raised both arms and sighted a distant object through the 2.5 cm hole in the center of the card. Again, two trials were run on each subject and a third trial was conducted when necessary.

Hand preference for both samples was determined by which hand was preferred for writing. Athletes were also asked which hand was preferred during their individual sports activity. It was found that some athletes used the non-preferred hand during the sports activity due to having crossed preference and using the preferred eye for sighting (eg. a pistol shooter with preferred right eye and left hand uses the right hand during shooting).

In cases where there was incomplete data for an athlete, the missing data were collected via the telephone. Instructions for the hand-over-hand method were given over the phone and the athlete reported which eye saw the sighted object. The instructions were as follows: Place your left hand flat on the table with the thumb and fingers forming an "L". Place your right hand on top of the left so that the fingers of the right hand cover those of the left at a perpendicular angle and the right thumb is on top of the left thumb. This should form a hole approximately two inches in diameter. Stand approximately ten feet away and directly facing a wall clock. Cross your hands as previously instructed, hold your arms straight and resting at waist level. Quickly raise your arms, keeping them straight and sight the number 12 throught the hole. Once you see the 12, do not move your arms. Close your left

eye and report if you still see the 12. Now repeat the procedure with your left hand crossing over your right hand.

Hand preference data requested over the phone was determined by responses to the following questions. With which hand do you write? Which hand do you prefer to use while participating in your sport? Hand preference for this research was determined by which hand was used during writing.

RESULTS

Total samples for this study were 268 athletes and 90 non-athletes. Comparisons evaluated between the two samples included ocular preference (See Table 1), hand preference (See Table 2) and eye/hand preference (See Table 3). A chi square (x^2) statistical analysis was used to evaluate the data. No significant difference was found between athletes and non-athletes for ocular preference, hand preference or eye/hand preference.

DISCUSSION

The results of this study reveal no general differences in ocular preference, hand preference or eye/hand preference in our samples of athletes and non-athletes. Ocular preferences were found to be comparable to the frequency of right eye preference previously reported (57%-70%).[9,10,11,12] Hand preferences were also comparable to the findings stated earlier of 60-91%.[8,9] The findings for crossed preference were comparable to those previously reported (18%-35%).[9,11,16,17]

Despite the findings in this study of no general differences between athletes and non-athletes in regard to incidence of eye or hand preferences, other research has shown that athletes in specific sports such as baseball[16] do differ from non-athletes on these variables. Further research is currently in progress to compare eye-hand preferences between athletes in different sports to identify specific patterns (eg. is crossed preference more common among baseball players and is homolateral preference more common among pistol shooters?). Comparisons between different positions within team sports may also show specific patterns as suggested by Portal and Romano[16] in their comparison of batters to pitchers.

The athletes in this study were young adult elite athletes competing for positions on the 1988 Olympic teams. Preference differences, if they exist, may

TABLE 1
OCULAR PREFERENCES IN ATHLETES VS NON-ATHLETES
(in percentages)

	RIGHT EYE	LEFT EYE
ATHLETE	66%	34%
NON-ATHLETE	73.3%	26.7%

TABLE 2
HAND PREFERENCE IN ATHLETES VS NON-ATHLETES
(in percentages)

	RIGHT HAND	LEFT HAND
ATHLETE	87.7%	12.3%
NON-ATHLETE	88.9%	11.1%

TABLE 3
EYE/HAND PREFERENCE IN ATHLETES VS NON-ATHLETES
(in percentages)

	HOMOLATERAL		CROSSED	
	RE/RH	LE/LH	RE/LH	LE/RH
ATHLETE	60.8%	6.3%	6.0%	26.9%
NON-ATHLETE	67.8%	5.5%	5.5%	21.2%

be more prevalent among more highly skilled athletes, and further evaluation of these individuals is indicated.

It has not been established that the preferred sighting eye is truly the dominant eye, or if it effectively directs overall athletic performance. Further research is recommended to determine if performance should be considered using the preferred sighting eye or using the controlling eye during binocular tasks. If the preferred sighting eye is to be used, a standardized test, such as the hand-over-hand method, needs to be established for determining the preferred eye. If the controlling eye during binocular tasks is to be used, the Dunlop test may be the appropriate test to determine the truly preferred eye. Further research is needed in this area to establish standardized tests for both monocularly preferred eye and binocularly preferred eye.

If it can be determined that the preferred eye, whether monocular or binocular, has an impact on sports performance, then a new question must be addressed. Is the preferred eye trainable, and if it is trainable, would training preferred patterns be of value if sport specific preference patterns are found to exist?

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