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VISUAL STANDARDS OF THE PARTICIPANTS IN THE SHAKLEE* JUNIOR SPORTS DEVELOPMENT PROGRAMME

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Abstract

47 junior sports athletes from the sports areas of track and field, swimming, gymnastics and tennis were assessed to determine their ocular responses in a variety of tests including visual acuity, stereoacuity, convergence and deviation size. Results indicate that overall these athletes achieved a high standard for most test procedures, with the tennis players achieving a significantly higher standard in stereoacuity tests. Junior athletes in the swimming groups demonstrated a reduced visual function.

Key words: *junior athletes, track and field, gymnastics, tennis, swimming, visual acuity, strabismus, heterophoria, convergence, accomodation, stereoacuity, ocular movements.*

This study was part of a programme to monitor the health of junior athletes and to study the effects of an intensive training programme undertaken by them.

The junior athletes were selected by the appropriate sporting associations for each of four athletic disciplines; namely track and field, gymnastics, swimming and tennis. The association were to name one male and one female from each of the age groups between 10 and 15 years. Thus the total expected in the programme was 48 athletes.

There were 47 athletes seen, of which 15 were from track and field sports area, nine were gymnasts, 11 were swimmers and 12 were tennis players. The age range of the athletes was between 10 and 15 years with an average of 13.3 years.

A series of general physical tests was carried out by the staff at Cumberland College of Health Sciences. Testing of the visual function was conducted by the staff of the School of Orthoptics.

METHOD OF VISUAL ASSESSMENT

Forty-seven athletes were screened. An ocular history was recorded which included details of the athlete's age, the sports area in which the athlete excelled, the presence of visual symptoms and any previous ocular treatment.

Visual acuity (Tables 1 and 2)

This was tested uniocularly with Snellen's test to the maximum level each athlete was able to read. The distance vision was tested at 6 m with a maximum level possible of 6/3. The near vision was tested at approximately 1/3 m using the reduced Snellen's test for which the maximum level possible was 6/5.

* Shaklee is an American multi-national company manufacturing and distributing natural cosmetics and multi vitamin supplements.

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TABLE 1
Visual Acuity Results

	Athletes		Brown
	Distance	Near*	
Vision 6/6 or better, both eyes	91.5% (43)	91.4% (43)	80%
Vision 6/6 or better one eye, 6/9 other	4.25% (2)	4.6% (2)	5.6%
Vision 6/9, both eyes	0	2.0% (1)	8.1%
Vision one eye less than 6/9	4.25% (2)	2.0% (1)	6.3%

* Tested with reduced Snellen's chart.

For athletes who wore glasses, vision was tested both with glasses and without glasses. For any athlete whose vision was reduced in either eye, the vision was retested through a pinhole. The maximum visual acuity obtainable is recorded and is used throughout the study as the visual acuity level.

Cover test and measurements (Tables 3 and 4)
Both tests were performed with the patient reading 6/6 print at both 6 m and approximately 1/3 m.

The measurement was performed by the prism and cover test method recording the prism strength below that which caused a reverse movement.

Ocular movements
These were tested in the nine positions of gaze. A cover test was performed in each position to demonstrate any slight variations in the deviation. This procedure reveals abnormalities which often have no significance in the primary position but may be of some significance on direct elevation and depression. The elevated position was particularly noted for potential involvement of the tennis players.

Convergence Near Point and Accommodation (Table 5)
These were both tested with the RAF rule and in cases when convergence near point was less than 6 cm convergence this was retested using an object. The distance, from the eyes, at which one eye failed to converge was recorded.

Accommodation was measured using N5 print moving the print away from the athlete. Both binocular and monocular tests were performed.

Stereopsis
This was measured in near position using the TNO stereotest. The level recorded for each athlete was the maximum level at which each athlete could see both plates correctly.

TABLE 2
Visual Acuity at 6 m

right eye \ left eye	<6/9	6/9	6/6	6/5	6/4	6/3
<6/9		1	1			
6/9			1			
6/6		1				
6/5				20	6	
6/4				2	14	
6/3						1

RESULTS

The number of studies conducted on general population groups is severely limited, therefore the information gained from this study could not be directly compared to a study of a population group of similar age, however, results are

TABLE 3
Cover Test Results

	Athletes		Brown
	%	No.	%
Athletes with strabismus	4.25%	(2)	3.5%
Athletes with orthophoria	21.25%	(10)	40.7%
Athletes with heterophoria	74.50%	(35)	55.8%

TABLE 4
Heterophoria Distribution (disclosed by cover test)

	Near	Dist.	Near and Dist.	Total		Brown
				No.	%	
Esophoria	5	0	1	6	17%	15.89%
Exophoria	26	0	3	29	83%	83.84%
Hyperphoria	0	0	0	0	0	0.27%
Total	31	0	4	35	100%	100%

Heterophoria Distribution (disclosed by cover test)

compared to four studies: one by Brown *et al.* (1977)[1] on children considerably younger, four to seven years; one by Frisby *et al.* (1981)[2] whose subjects had a mean age of about 20 years; one by Mazow (1983)[3] on subjects whose ages ranged between 6 and 74 years; and one by Turnbull (1978)[4] whose ages ranged between 4 and 71 years.

Symptoms

Seven athletes had headaches or discomfort for near, five of these had an excellent ocular standard with full convergence and normal accommodation. One had deficient convergence (9 cms) and one had microtropia.

It is interesting to note that gymnasts were the only athletes who were symptom free. It is also interesting to note that the athletes from the swimming discipline were the only athletes who had been prescribed optical correction, one being myopic.

Visual Acuity

The recorded maximum levels of visual acuity (Table 2) demonstrate that the majority of the athletes (91.5%) had vision at 6 m of 6/6 or better in both eyes. When comparing the results to a study carried out by Brown *et al.*[1] on 5,436 kindergarten children it can be seen (Table 1) that despite the differences between the ages of the subjects and the testing procedures in the studies, the overall distribution of vision responses of the athletes is similar to the distribution of vision responses of the kindergarten children.

The athletes had a greater proportion (91%) with vision 6/6 or better in both eyes, which possibly may have been related to age and their greater ease of performing the test.

Analysis of the range of visual acuity levels within the different sports groups showed that the swimming group had a level which ranged between 6/4 and 6/24 for distance and from 6/6 to 6/60 for near, whilst the remaining groups ranged between 6/3 and 6/9 for distance and from 6/6 to 6/9 for near. Bearing in mind the small number (11), the results for the swimming group suggest that visual levels are not as important for this group as for other groups.

Deviation type

The distribution of the type of deviation as determined by the cover test is similar to the distribution found by Brown *et al.*[1] (Table 3) with the smallest percentage of deviations being strabismus. One of the athletes who had strabismus was from the swimming group and the other from the track and field group. The athletes had a significantly higher proportion of members with an heterophoria than the kindergarten children ($P > 0.99\%$ using chi square test). Within the heterophoria category the distribution into esophoria, exophoria and hyperphoria shows no significant difference between the two studies (Table 4).

Deviation measurement

When the squints were excluded the average deviation size measured -2.97 prism dioptres for near and for distance was found to be -0.5 prism dioptres which relates well to the high incidence of exophoric deviations in the athletes as a whole.

Convergence

Results (Table 5) showed that most athletes had a level of convergence between 0 and 5 cm which

TABLE 5
Convergence Near Point—Result

	Athletes		Brown
	%	No.	%
Near point 0-5 cms	68	32	86.4%
Near point 6-10 cms	27.75	13	12%
Near point 11 cms +	4.25	2	1.6%
	100%	47	100%

Brown *et al.* classified as normal. Whilst the majority of athletes do fall within this range, the porportion of athletes in this category is significantly lower than that disclosed in the study of Brown *et al.* ($P<99\%$) and there are comparatively more athletes found in the reduced range of 6-10 cms ($P>99\%$). It is possible that the shift of distribution may be age related considering that the age of the majority of the subjects in the study by Brown *et al.* was five. Only one of the athletes in the group with reduced convergence had symptoms associated with close work.

Of the different sports groups, the tennis players had a higher proportion of members (83%) whose convergence was in the 'normal' range. However, because of the small sample size, the evidence is statistically inconclusive.

Accommodation

For each athlete, the level of accommodation for each eye was measured and compared to the athlete's expected level for age: the difference between the two levels for the left eye (L) was plotted against the difference between the two levels for the right eye (R) (Figure 1). The majority of the athletes showed the same standard for each eye ($L=R$), 25 above the normal level of accommmodation for the individual's age, eight with normal accommodation and five below normal. The other nine had different levels for each eye. The correlation between L and R is highly significant ($P>99.9\%$) and the least square linear regression equation was found to be $R=0.99\ (\pm0.10)\ *\ L+0.06\ (\pm0.22)$.

Tennis players and gymnasts showed their accommodation ability to be between normal and better than their age level whilst athletes for the track and field and swimmers were found across the full range. When the tennis players and gymnasts were grouped together and compared to the combined group of swimmers and track and field athletes, the responses of the tennis/gymnast group were found to be significantly better ($P>98\%$ using a chi square test) than the swimming/track and field group.

Stereoacuity (Table 6)

The responses for the group of athletes in this study were that 57.4% gained better than 60 seconds of arc with 46.8% gaining 30 seconds and 10.6% gaining 15 seconds of arc. The mean score for the group as a whole is 44.3 (±25.7) seconds of arc. The means for the individual groups were found to be: tennis 31 (±9.6) seconds, gymnasts 47 (±14.8), track and field 46 (±25.6) and swimmers 55.5 (±37.4) seconds of arc. Further analysis of responses in the individual sports groups shows that the gymnasts

TABLE 6
Stereopsis results—T.N.O.

	Seconds of Arc							Total
	15	30	60	120	240	480	nil	
Track and field	1	7	5	1			1	15
Gymnastics		4	5					9
Swimming	3	1	4	2			1	11
Tennnis	1	10	1					12
Total	5	22	15	3			2	47
Percent	10.6	46.8	31.9	6.4			4.3	100%

/// mean per Mazow
\\\ mean for athletes

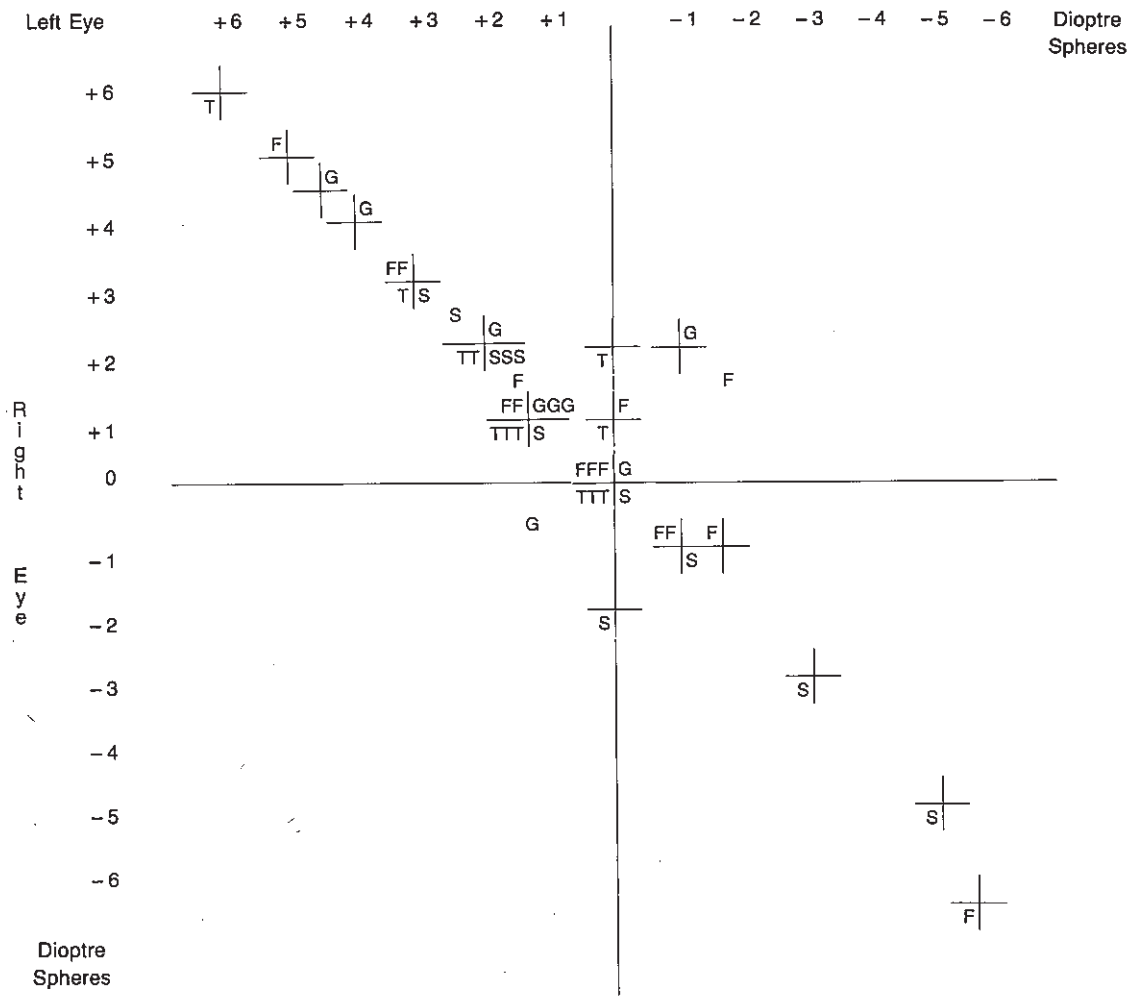

Figure 1: Accommodation responses.

and tennis players all appreciated stereopsis to a level of 60 seconds or better and that the responses of 90% of the tennis players were at a level of 30 seconds of arc or less. A chi-squared test of the response of the tennis players against the response of other athletes showed that the tennis players tested had a significantly higher level of stereoacuity (P > 99%).

Frisby *et al.*[2] in a comparative study of stereotests assessed 68 university students whose mean age was about 20 years. The mean of their initial response to the TNO test was 82 seconds of arc. This was almost double the value for the present study (44.3 seconds of arc) and the difference was found to be highly significant using a Student's t-test (P > 99.9%). Unfortunately, Frisby *et al.* did not tabulate their results, however, the distribution of their responses can be deduced from their graph and shows that there is a significant difference in the TNO results using chi-square test (P > 95%) between Frisby's group and the athletes. The responses of the athletes also showed much less variance than the responses of Frisby's subjects.

TABLE 7
Ocular Movement—Results

Athlete Group	Full Movements		Abnormal Movements	
	No.	%	No.	%
Track and field	6	40%	9	60%
Gymnastics	4	44%	5	56%
Swimming	7	63%	4	36.4%
Tennis	9	75%	3	25%
	26	56% (30.4%) Turnbull	21	44% (69.6%) Turnbull

Using the F-test, the difference was found to be highly significant ($P > 99.9\%$).

In a study to assess three stereoacuity tests Mazow[3] performed the TNO test on 50 subjects with ages in the range of six to 74 years, whose visual acuity was better than 6/9 and who had no squint. Mazow found the mean response to be 193.56 seconds of arc with a standard deviation of 17.98 seconds. This is a much reduced stereoacuity standard when compared to the response of the athletes in the study ($P > 99\%$) using the Student's t-test.

These results suggest that the athletes in this study and, in particular, tennis players have superior stereopsis.

Ocular movements (Table 7)

Forty-four per cent of the athletes demonstrated slight abnormalities of ocular movements with the majority of these being bilateral inferior oblique overaction. This is a similar finding to that of Turnbull,[4] and in most instances was only evident in extreme positions of gaze.

Fifty-six per cent of the athletes had full ocular movements. Comparing these responses to those found by Turnbull who, using the same testing procedure, found normal ocular movements in 30.4% of her group, it can be concluded that the results for the athletes is significantly better ($P > 98\%$ for chi-square test).

The tennis players had the largest proportion (75%) of athletes with normal ocular movements, which again suggests that visual function is more important to the performance of tennis players than to the performance of other tested athletes. (Not statistically significant due to small sample.)

CONCLUSION

Overall, the athletes in this study have better visual function than other population groups to which they have been compared. As discussed above, age differences between the groups may be a factor contributing to the observed visual standards. There is insufficient evidence on which to propose causative factors. Perhaps the differences are related to a difference in the athletes attitudes; their desire to achieve in their sporting endeavour may encourage a parallel approach in all activities. Alternatively one could speculate on whether the sporting activity promotes better visual performance or whether the visual performance enables premium sports performance.

It has been suggested that many people who are myopic and are talented athletically will preferentially develop their swimming skills because vision is less important in that sport. Consideration of athletes in the swimming group with accommodation better than age expectations, showed that all such people had no current difficulty with distance vision, their level being 6/4-6/5 in each eye. Only one of the swimmers was myopic. However, there were no myopic athletes in any other sports groups. It is also interesting that the athletes with the most reduced vision were swimmers and that one of the two athletes with a squint was a swimmer (the other athlete with strabismus was in the track and field group).

Conversely, tennis players had significantly better stereoacuity responses than other athletes and, together with gymnasts, had above average accommodations.

The results of this study, although representing only a modest number of athletes, suggest that the natural selection operating in sporting activities could be influenced by visual standards. Further work both on large groups of athletes and on the general population to establish average age-related visual standards should provide greater insight into this aspect and may

prove of benefit in the training and selection of athletes.

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