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Research article

COMPARISON OF VISUAL ACUITY IN REDUCED LUMINATION AND FACILITY OF OCULAR ACCOMMODATION IN TABLE TENNIS CHAMPIONS AND NON- PLAYERS

Ebrahim Jafarzadehpur ✉ and Mohammad R. Yarigholi

Optometry Department of Iran University of Medical Science (IUMS), Tehran, Iran

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ABSTRACT

A table tennis player should fixate at different distances; track the objects with different speed, and in different visual environment. Their visual skills must be well developed for these capabilities. Therefore, visual acuity in reduced lumination and facility of ocular accommodation those are two criteria for visual skills have been compared in table tennis players and normal non-players. Twenty-nine young table tennis champions and 29 normal matched non-players (did not take part in any racket sports game) were evaluated. Basic visual and eye examinations were done for both of them. Normal results in basic examination were fundamental requirement for all the subjects. +/-2.00 sphere lenses for accommodation facility are used. An electrical current regulator changed the output light intensity of a conventional chart projector (Topcon). Light intensity decreased to 10 $cd \cdot m^{-2}$ and visual acuity tested. In comparison of visual acuity in reduced lumination and facility of ocular accommodation in table tennis champions and non-players there are significant differences ($p < 0.001$). In the preliminary visual tests there was not any significant different in the two groups but the results in the top level table tennis player was very uniform and in every test and the standard deviation was lesser in tennis player group than non-players. These results show that motor and sensorial functions of expert players are well developed. That is consistent with other researchers. This result was interpreted as reflecting a better perceptual system of experts to the constraints encountered during table tennis and its use in practical settings for evaluating athletes or detecting sport talents. However some visual and perceptual training that usually used in orthoptics can be used for novice table tennis player to improve their abilities.

KEY WORDS: Racket sports, visual acuity, and ocular accommodation, table tennis.

INTRODUCTION

In the second century Galen (131-201) believed that there is a relation between ball sports and body and visual status (Hitzeman and Beckerman, 1993). Despite this primary point of view about visual importance in sports, it has been forgotten for many years. In the middle of 20th century new scientific opinions for sports were developed. They think that sports are a multidisciplinary approach. Science and technology developments influence sports prominently. All the sports game may develop human sensory and motor systems. But every one may influence specific system selectively.

Table tennis is a dynamic sport that training of sensory and motor systems may be more influence in expert performance (Seve et al., 2003). Different sensorial and motor systems actively contribute the sportsman achievements or failures. Three-dimensional kinematics analysis of line-of-gaze, arm and ball was used to describe visual and motor behavior. This study determines the role of head, eye and arm movements during the execution of a table tennis forehand stroke (Rodrigues et al., 2002). The

conceptual and methodological frameworks of co-ordination dynamics can be applied, appropriately, to the analysis of discrete movements in table tennis players (Sorensen et al., 2001). Table tennis players use saccadic eye movement, in saccadic eye movement first and last point of fixation is very important (Ripoll and Latiri, 1997). Therefore, accommodative system should follow fixation point appropriately. Visual system is an important sensorial and motor coordinator of human activities. Skilled players were faster than their less skilled counterparts in anticipating the direction of opponents' tennis strokes, with this superior performance being based, at least in part, on more effective visual search behaviors (Williams et al., 2002). The similar results for visual system can be found in other researches (Totterdell, 2000; Abernethy et al., 2001; Fery and Crognier, 2001; Rowe and McKenna, 2001). There are many connections between visual system and postural and proprioceptive systems. A table tennis player should fixate on a small ball that moves very rapidly in the free space with lack of spatial clue. Additionally he should see the opponent and table simultaneously. These visual actions take place in reduce contrast and dynamic fixation environments.

According to this situation the player should change his accommodation very rapidly and correctly. However they should be able to retain their visual performance in spite of reduced contrast and luminance differences of objects.

It seems that the functions of the visual system in table tennis players may be more developed, and some visual skills in table tennis players may be better than the novice. If it so, we must try to find out, which skill may be more prominent. Therefore two visual skills; visual acuity in reduced lumination and facility of ocular accommodation in table tennis champions and non-players was compared.

METHODS

Twenty-nine expert table tennis players were chosen. These young male (18-25 years old) had at least five years experience and they were champion in different national and international games. The main inclusive criterion for champion invitation was their championship. According to table tennis ranking in Iran we call them on from top to down, and explained about the research. A specific time was fixed for every one. The elites were evaluated for any systemic and visual problems. They were asked about any history of medication and systemic disease. The following visual and ocular tests have been done for them.

1. Visual acuity test with Topcon chart projector at six meter and Snellen near acuity chart for forty centimetres. These tests have been done in photopic condition.
2. Objective refraction by static retinoscopy and autorefractometry and subjective refraction including: visual acuity, cross cylinder, Bichrome test has been done for every subject. Hyperopia lesser than 0.75, myopia, against the rule and oblique astigmatism lesser than 0.25 and with the rule astigmatism lesser than 0.5 considered normal and accepted in this study.
3. Ocular motility evaluations consist of heterophoria and fusional vergence recording at far and near distance. The results assessed according to compensation criteria.
4. Amplitude of accommodation measured by push up technique.
5. Biomicroscopy and ophthalmoscopy of the eye for all the subjects.

The entire tests for two groups were done in the clinic of the optometry in the Iran University of Medical Science (IUMS).

The table tennis champions compared with non-players. The control group age, education and sex were the same and similar visual and ocular exam were done for every subject. We try to match a champion with a specific non-player with same age, education and sex. According to an Iranian law “Every champion can enter the university (usually in sports college or university) without any qualifying entrance exam”. Therefore most of champions are student and we could select the control group from other male students in IUMS. The systemic and medication history evaluated in same manner. Every person in the control group matched by an elite.

The main difference between table tennis player and control group was that, they don’t play any ball- racket games seriously or even as a hobby.

After preliminary exams a code assign to every person in two groups. An optometrist that didn’t know about subject’s group measured the acuity in reduced luminance and facility of accommodation. He used +/-2.00 sphere lenses for accommodation facility. A near chart positioned at 40 centimetres in front of subject. He instructed to fixate at 20/25 row in well illuminated examine room (Griffin, 1988). The subject should read aloud every optotype that optometrist wants. At the same time the flipper power change. The subject asked about clearance of optotypes. The optometrist waits for clear vision in every change of flipper. He counts the cycles of flipper changes per a minute as a criterion for accommodation facility.

Acuity in reduced luminance is another test that the examiner did not know about the subject’s

group. A conventional visual acuity chart projector (Topcon, Japan) used for acuity measurement. An electrical current regulator changed the output light intensity of projector. Light intensity at acuity screen measured by a photometer (Leibold, Germany). Light intensity decreased to 10 $cd \cdot m^{-2}$ and visual acuity tested. For all the subject acuity measurement is done according to 75% correct answer for every row. All data was recorded in a specific record card that its code is unique for every person. The data analyzed statistically by Statgraphics statistical package.

RESULTS

Descriptive and analytic statistics have been you for recorded data. As it shown in table 1 the average and standard deviation of the conventional acuity measurements in two groups are the same. This result is predictable because one of the inclusive criterions for groups was 20/20 or better conventional acuity.

The equivalent sphere of the recorded refractive error shows that ametropia is lesser in table tennis players. However there is not a significant difference between two groups. The standard deviation is lesser in elite; it is mean that inter-subjects differences are lesser in this group.

All of the results in preliminary exams aren't the same in two groups, but the differences are not significant. The results of preliminary exam in table tennis player are better than non-player. The average and SD of results are better in champions.

Two variables that evaluated in two groups are significantly different in table tennis player and non-players (Table 1). Facility of accommodation is significantly ($p < 0.001$) better in table tennis players. In facility test, as it shown in table 1, the frequency of clearance in sports man is 14 cpm but in other group it is 9 cpm. Visual acuity in reduced lumination is also significantly ($p < 0.01$) different in two groups. As it shown in table 1 acuity reduction in non-player is more prominent. In other word sports man can retain 20/20 acuity despite of luminance reduction. This is seen in a situation that all first acuity measurement was the same. Acuity changes and inter-subject differences in champion were lesser. It means that acuity is more stable in champions.

DISCUSSION

As the results shows there is significant differences between facility of accommodation and acuity in reduced lumination in champions and normal non-players. Development of these two parameters may improve the efficiency of visual system.

Facility development may shorten the time that visual system needs for taking a clear image. In table tennis fixation points change as fast as the ball and opponent velocity change. The velocity of ball is very high and the eyes should clearly see it. Therefore any person that can follow the ball as fast as possible, he would be more successful. Saccadic eye movements are used for fixation on the ball (Ripoll and Latiri, 1997). Suppression takes place in saccadic eye movements. Only the first and last point of fixation can be seen and along the saccadic pathway suppressed (Ripoll and Latiri, 1997). Therefore the first and last point is very important from visual acuity point of view. A table tennis player should change his accommodation as fast as his saccadic eye movements for his achievements. There is close relationship between accommodative system and vergence and binocular vision system (Griffin, 1988). Binocular vision improvement factors usually improve facility of accommodation and also binocular vision anomalies cause anomalies of accommodation (Pickwell, 1986). Table tennis improves binocular vision (Ripoll and Latiri, 1997) therefore; it may cause improvement of accommodation facility.

Table 1. The results of different tests. Data are means (SD).

	Non- players	Table tennis players
Visual acuity	20/15 (0.1)	20/15 (0.1)
Refractive error (Eq.) (dioptre)	+0.38(0.6)	+0.34 (0.4)
Amplitude of accommodation (dioptre)	9.2 (0.95)	9.6(0.75)
Far phoria (prism dioptre)	–0.57 (1.9)	-0.57(1.2)
Near phoria (prism dioptre)	– 1.5 (2)	- 1.3 (1.5)
NPC (cm)	7.8 (4.3)	6.4 (2.7)
Far Fusional divergence (prism dioptre)	7.7 (3.3)	8 (2.5)
Far Fusional convergence (prism dioptre)	16 (8.7)	16.2 (7.2)
Near Fusional divergence (prism dioptre)	9.2 (3.8)	9.3 (3.5)
Near Fusional convergence (prism dioptre)	16.9 (8.3)	17.9 (5.5)
Facility of Acc. (cycle per minute)	9.7 (5.9)	14.3 (4.5) ***
Acuity in reduced lumination	20/25 (0.22)	20/20 (0.2) **

** $p < 0.01$, *** $p < 0.001$

Another point that may explain improvement of accommodation facility in table tennis players is autonomic system. Accommodation controlled by autonomic system and recent study (Ferrauti et al., 2001) shows that autonomic system in tennis players may be more efficient. It seems all the above-mentioned factors may improve the facility of accommodation.

Acuity in reduced lumination is another skill that evaluated in this study. As it shown there is a significant ($p < 0.01$) differences between table tennis players and non-players. Visual acuity test is one of psychophysical tests. In psychophysical tests the respond of subject depends on peripheral and central nervous system, but perceptual centers involve prominently in the respond process. It seems perceptual systems are more efficient in champions. Other studies in racket-ball sports (Totterdell, 2000; Abernethy et al 2001; Fery and Crognier, 2001; Rowe and McKenna, 2001; Williams et al., 2002) show that sensory; motor and perceptual conditions in champions are more efficient than novice and non-players. An expert player should anticipate ball trajectory, direction of opponents' strokes, opponent's stroke movements, and opponent's pattern of play. Also temporal and spatial judgments of ball, environment and opponent in a short time should be done. And specific motor abilities for effective visual search must be considered for any successful player (Totterdell 2000; Abernethy et al., 2001; Ferrauti et al., 2001; Fery and Crognier, 2001; Rowe and McKenna, 2001; Williams et al., 2002). Naturally the above sensory, motor and perceptual advantage of elite may result better psychophysical performance of champions (Vergauwen et al., 1998).

Reduced lumination cause Purkinje shift. Visual acuity in Purkinje shift would be reduced (Boyce, 1973). As it shown in this study, better acuity can be seen in table tennis players than non-player in reduced lumination. According to this study and similar studies we can deduct that table tennis player can retain good visual acuity despite of unsuitable environmental conditions.

CONCLUSIONS

Two visual skills, facility of accommodation and visual acuity in reduced lumination, are shown that significantly developed in table tennis players. In this study we just describe the visual performance of table tennis players and non-players in restricted aspects. This study shows that the visual skills may be different in table tennis players and non-players. We don't know the visual skills development is a primary phenomenon, i.e. every person with well-developed visual skills progress very fast in table tennis, or it is secondary to table tennis practice. Nevertheless, the main point is that, the visual skills are very important in table tennis players.

The other point that may be interesting for further research is the quantitative evaluation of visual skills developments in table tennis players. If the visual skills are primary in table tennis players, it will be useful for better evaluation and selection of the players. If it is secondary to table tennis practice, orthoptics and visual skills development by special training will be considered.

Other visual skills should be tested in another research. Other visual skills may be more descriptive and determinative in table tennis players. At the end, it should be mentioned that the couches and talent scouts should not concentrate only on the physical performance of players. They should be aware that, the vision is a factor that may influence the physical performance of an athlete.

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AUTHORS BIOGRAPHY

Ebrahim JAFARZADEHPUR
Employment
Assistant Professor of Iran University of Medical Science
Degree
BSc. MSc. PhD
Research interests
Sports vision, VEP and psychophysics
Email:jafarzadehpur@iums.ac.ir

Mohammad R. YARIGHOLI
Employment
optometrist
Degree
BSc
Research interests
Sports vision

KEY POINTS

- That the ability of a champion depends on many sensory, motor and perceptual factors.
- Visual factors such as facility of accommodation and visual acuity in reduced lumination should be considered in table tennis players.
- Visual training may be useful for novice and also for experts.

✉ **Dr. Ebrahim Jafarzadehpur**
Optometry Department of Iran University of Medical Science (IUMS), Tehran, Iran