

Differences in Peripheral Perception between Athletes and Nonathletes

by
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In team games, due to the great number of stimuli, perceptive skills have a cardinal significance, especially in players' anticipation and decision-making processes. The aim of this study was to compare peripheral perception of handball players (n=16) and nonathletes (n=16) of the same age. A comparative analysis involves abilities connected with general visual functions - such as the field of vision (hardware system) and reaction time to visual stimuli (software system). Peripheral perception was examined using the peripheral perception test included in the Vienna Test System (Schuhfried, Austria). The results indicate that the examined groups did not differ in regards to visual functions connected with the peripheral field of vision and the correctness of stimuli recognition. Handball players had a significantly shorter response time to stimuli appearing in the peripheral field of vision compared to nonathletes.

Key words: peripheral perception, team games, athletes.

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Introduction

The basic elements of sports vision include visual reaction time and peripheral vision (Planer, 1994). Both these factors significantly influence the perceptual abilities of an athlete, although they have fundamentally different backgrounds. Peripheral vision is influenced by general functions of the human visual system. Reaction time is connected with information and cognitive processes of movement control and regulation, influenced by the functions of the central nervous system and muscle effectors. Motor reaction time is the period of time between the signal and completion of an action (Raczek, 1991), thus it has both sensory and motor characteristics.

Abernethy (1987) described the visual system as mutual interactions between variables of the system, namely hardware and software. In sports, the hardware system is understood as the mechanical and optometric properties of the visual system, unrelated to specific activities (i.e., visual acuity, ocular health, binocular abilities like accommodation (focus and fusion), depth perception, color discrimination, and peripheral vision). These visual functions can be measured using standard optometrical techniques. The software system is connected more with cognitive aspects: visualization, visual concentration, visual perception, reaction time to visual stimuli, and visual search.

The issue of visual perception in athletes is still not thoroughly researched. On one hand, some reports show that visual functions in athletes are better than in nonathletes, and professional athletes have better parameters of the visual system than lower level athletes. Such conclusions can be drawn from work by Ishigaki and Miyao (1993) on the dynamic visual acuity of 53 athletes and 46 nonathletes, all university students. Christenson and Winkelstein (1988) also showed that athletes are significantly better than nonathletes in certain visual skills: vergence facility, saccades, visual reaction time, peripheral awareness, and near point of convergence.

Savelsbergh et al. (2002) examined the visual search ability during penalty kicks in goalkeepers with varying levels of experience. The visual search behavior was registered by an eye movement registration system. It was observed that skilled goalkeepers were usually more accurate in predicting the direction of penalty kicks. They took more time to make a decision and made fewer corrective movements. They also used more efficient strategy of focusing their vision, with fewer fixations on details, and the spots they focused on were more similar within their group than in the group of inexperienced goalkeepers.

However, Ward et al. (2000) examined the vision of footballers aged 8-18 years with various levels of expertise, using standard measurements of static

and dynamic acuity, stereoscopic depth, and peripheral visions. They observed an increase in visual function associated with age, but expert athletes did not have much higher results than players with less athletic experience. Besides, none of the compared groups showed visual functions that were higher than average from the general population.

Ciućmański and Wątroba (2005) showed that for peripheral vision, depth perception, and the ability to visually track a moving object, 12-year footballers had better results than their non athletic peers. It was observed that training which focused on developing visual perceptive abilities, increased the levels of these abilities and consequently the efficiency of an athlete's perception.

The aim of this study was to compare peripheral perception (reaction time to stimuli in the peripheral field of vision) of handball players and non athletic peers. The study involved team game players, for whom perceptual skills are of particular importance, especially in the players' anticipation and decision-making processes, due to a great number of stimuli. A comparative analysis in this study involves abilities connected with general visual functions, such as the field of vision (hardware system) and reaction time to visual stimuli (software system).

Material and methods

The research involved 16 handball players from division II. Their mean age was 21.86 ± 1.09 years, with sports experience of 10.37 ± 3.63 years. The control group included 16 non athletic students of a State Technical Institute (20.12 ± 1.82 years old). The experiment took place in October 2007. The Bioethical Committee at the Medical University in Poznań, approved the research project.

Peripheral perception was examined using the peripheral perception (PP) test included in the Vienna Test System (Schuhfried, Austria) (Fig.1). The test consisted of two kinds of tasks conducted simultaneously: one concerning peripheral perception and the other related to centrally-oriented tracking deviation (attention of the examined person was focused in the center of the field of vision). The task of evaluating peripheral perception comprised of observing flashing vertical lines which, at different times, appeared in the peripheral vision. When a player recognized the lines, he reacted by pressing a foot pedal. The device generated 80 impulses, 40 of which appeared to the left and 40 to the right. Tracking was controlled by steering a "view-finder" with knobs, so that the "view-finder" tied in with a red point on the screen. Proper positioning of the "view-finder" was confirmed by a flickering of the point. In the test, the position of the head (eyes) of the examined players was measured in relation to the field of observation. The device enabled the introduction of an adaptive

algorithm, guaranteeing the occurrence of impulses in a suitable, informational position for every person investigated, (i.e. in such a way that they perceive at least 50% of the impulses). In the adaptive mode, non-informational stimuli, constituting information noise, were not considered.



Fig. 1

Station for the measurement of peripheral perception.

The following variables were recorded: field of vision (n°), visual angle left/right (n°), tracking deviation (in pixels), number of correct reactions - left/right stimuli (n), number of incorrect reactions (n), number of omitted reactions (n), and median reaction time - left/right stimuli (s).

The statistics included mean (\bar{x}), standard deviation (SD), minimum value (min) and maximum value (max). The data were analyzed by one-factor analysis of variances (ANOVA). Statistical significance was set at $p < 0.05$.

Results

Table 1 presents the test results concerning peripheral perception in the groups of handball players and nonathletes. No statistically significant differences were observed between the two groups regarding most of the analyzed variables, especially those related to peripheral vision, (i.e., field of vision, number of correct reactions, and number of incorrect reactions), although arithmetical means of these variables were a little higher in nonathletes than in handball players (Fig.2). Nonathletes had better PP test results with regards to omitted reactions ($F=5.20$, $p < 0.05$). Handball players had significantly better results regarding reaction time to visual stimuli, both in left ($F=6.95$, $p < 0.01$) and right peripheral vision ($F=8.34$, $p < 0.01$) (Fig.3).

Table 1

Test results concerning peripheral perception in the groups of handball players and nonathletes.

Test PP	Athletes		Nonathletes		F
	$\bar{x} \pm SD$	min-max	$\bar{x} \pm SD$	min-max	
Field of vision (n°)	170.95±9.15	155.7-186	173.76±3.82	169.1-181.7	1.05
visual angle/left (n°)	90.11±6.32	78.1-98.3	91.73±2.97	87.7-98.6	0.71
visual angle/right (n°)	80.84±6.69	62.7-89.3	82.02±2.75	77.3-87.1	0.35
tracking deviation (pixels)	11.11±1.09	9.3-12.7	13.87±2.10	9.1-17.2	0.35
number of correct reactions/left (n)	18.15±2.82	11-20	19.00±1.35	16-20	3.06
number of correct reactions/right (n)	18.29±2.46	13-20	19.15±0.98	17-20	1.40
number of incorrect reactions (n)	1.36±2.21	0-8	1.53±1.39	0-5	0.06
number of omitted reactions (n)	2.54±3.15	0-9	1.84±1.77	0-5	5.20*
median reaction time/ left (s)	0.55±0.07	0.47-0.65	0.63±0.08	0.51-0.86	6.95**
median reaction time/right (s)	0.54-0.05	0.44-0.66	0.61-0.08	0.52-0.82	8.34**

*p<0.05

**p<0.01

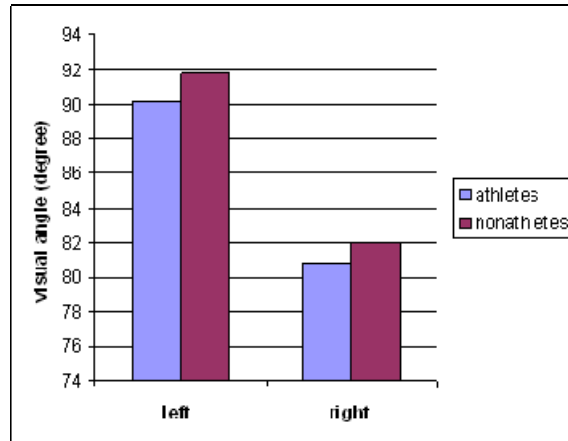


Fig. 2

Field of vision in left and right visual angle

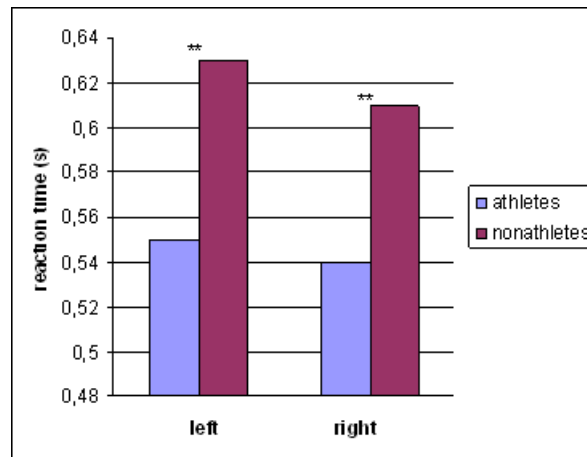


Fig.3

Visual reaction time in left and right peripheral vision

* $p < 0.05$

** $p < 0.01$

Discussion

The aim of this study was to determine the differences between experienced handball players, and nonathletes, with regard to their peripheral perception abilities. The results show that the examined groups did not differ in visual functions connected with the peripheral field of vision and the correctness of stimuli recognition. The handball players did not have visual functions concerning peripheral vision at a higher level than nonathletes.

The main difference between the groups was regarding reaction time. Handball players had significantly shorter reaction times to visual stimuli appearing in the peripheral field of vision. However, in this study a greater number of omitted reactions were observed in experienced players than in nonathletes, which is difficult to explain and contrary to expectations.

The results can be compared with those by Venter and Ferreira (2004), who assessed visual skills in rugby players from different age groups. The authors expected that age, along with accompanying motor development, could also influence visual perception skills. Their research showed statistically significant ($p < 0.05$) superiority of the older group in eye-hand coordination, eye-body coordination, and reaction time to visual stimuli (software skills). The younger group, however, had better results in tests investigating static visual acuity, contrast sensitivity, and stereoscopic examination (hardware skills).

Ando et al. (2001) also proved that the central and peripheral visual reaction time of soccer players is significantly shorter than that of nonathletes. Their results suggest that soccer players are better able to respond quickly to a stimulus presented to both their peripheral and central visual fields.

One of the fundamental functions of peripheral vision is to focus attention on objects perceived outside the central field of vision. The photoreceptors in the human retina are not evenly distributed. The further from the central fovea of the retina, the lower the density of the receptors, and consequently the lower the visual resolution (Curcio et al., 1990). The rod receptors, primarily located in the periphery, are sensitive to light and motion. Visual acuity at the extreme periphery falls to 4 percent (Williams et al., 1999), which is why peripheral visual reaction time is significantly longer than central reaction time. The study by Ando et al. (2001) indicates that peripheral visual reaction time is slower than central visual reaction time due to an increment in premotor time.

It seems that a higher level of visual perception in athletes is more related to recognition speed and responsiveness to stimuli than the functioning of the visual system in the peripheral field. However, some researchers argue that sport disciplines which require multiple stimuli involvement of visual perception improves peripheral vision. For example, Blundel (1982) investigated pe-

ipheral vision in tennis players of different sports level, from novice to international players. Peripheral sensitivity was determined using different color lights. Results show that these elite athletes had a significantly wider field of vision than novice athletes with regards to white and yellow.

Similarly, Williams and Thirer (1975) showed statistically significant differences between athletes playing American football, fencing and tennis vs. nonathletes with regard to the central and peripheral fields of vision. However, in either case it is difficult to determine whether wider peripheral vision was an effect of training, or was perhaps due to the initial selection of the players.

Some researchers also point to the role of specific visual training programs for improving visual abilities (Stine et al., 1986, Hitzeman and Beckerman, 1993; Williams, 2003) . In a study by Adolphe et al. (1997), expert volleyball players took part in a six-week-long session of perception training, in order to improve their visual search behaviors and to increase performance accuracy in passing to the setter. The program was based on video techniques showing the gaze behaviour, and field-based techniques, such as ball detection, tracing, and passing skills. Results showed improvements in tracking onset, tracking duration, and the ability to maintain a stable view of the contact point. Kohmura and Yoshigi (2004) showed that the perceptual training methods (computer software program for improving and measuring visual function) improved the visual functions of college male baseball players. In their study, significantly higher values ($p < 0.01$) in player's visual field were observed even after four weeks of training.

Abernethy (1987) suggests that in case of visual processes, the software system differentiates elite athletes from nonathletes. It seems that results of this study fully confirm this hypothesis. However, it is difficult to ascertain whether the higher level of responsiveness to visual stimuli in the examined handball players was due, to their genetic endowment, or was a result of training.

Conclusions

1. Visual functions connected with peripheral vision did not differentiate athletes from nonathletes. Handball players compared to nonathletes did not show higher levels of peripheral vision with regards to field of vision, width, and correctness of reaction to visual stimuli.
2. Handball players had a significantly shorter response time to stimuli appearing in the peripheral field of vision compared to nonathletes.

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