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PERIPHERAL VISION IN BASKETBALL PLAYERS AT DIFFERENT LEVEL OF EXPERIENCE

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Abstract
Introduction. This study focuses on the sensory information delivered by the visual system, particularly in the peripheral visual field (PVF). Visual abilities, especially the ability to detect peripheral information, have been identified as important factors for successful performance in team sports. Athletes often need to divide their visual focus between central and peripheral fields to achieve optimal performance. However, research on visual perception in athletes with varying levels of experience is still limited. The aim of the study was to compare peripheral perception of basketball players at different level of experience. ***Material and Methods.*** In study 165 basketball players took part at different level of experience. An analysis compare abilities general visual functions (i.e. field of vision) and reaction time to visual stimuli. Peripheral perception was examined using the peripheral test included in Vienna Test System (VTS, Schuhfried, Austria). During the test variables were recorded: total field of vision, viewing angle of the left and right eye., tracking deviation, number of correct reactions, the number of omitted responses and median reaction time – left and right stimuli. ***Results.*** The results indicate that the E and U19 groups had significantly shorter response time to stimuli appearing in the peripheral field of vision compared to U15 group. Two more experienced groups had bigger field of vision than U15. No statistically significant differences were observed between E and U19 group. ***Conclusions.*** The study highlights the importance of perceptual skills, particularly in anticipation and decision-making processes, for basketball players due to the high number of stimuli involved in the sport. Understanding these differences can inform training strategies and help identify areas that may require additional attention for optimal performance. The accumulation of high volume of sport specific exercises may facilitate the development of perceptual exper¬tise in basketball players.

Key words: peripheral perception, visual perception, Vienna Test System, basketball

Introduction

Sensory information delivered by the visual system is an intricate process that is used and relied upon more than the other sensory systems [1]. Visual information can be received within the central visual field (CVF) and peripheral visual field (PVF). The central vision, also referred to as foveal vision, detects information within the CVF, and refers to the small visual area in which information can be gathered with very high visual acuity (i.e., clearness of vision) [2]. Foveal vision receives visual information within the middle 2° to 5° of the visual field [1, 2]. The clarity of vision (i.e., visual acuity) decreases as the visual information becomes further from the center of the visual field [3]. The ability to receive visual stimuli that are located outside of the CVF, is referred to as a peripheral vision [4]. The peripheral vision receives visual information in the PVF at approximately 160° vertically and 200° horizontally [1, 5]. The peripheral visual information detected in the PVF is characterised by high motion sensitivity but low spatial acuity [5]. In other words, objects can be recognized quite well in the PVF, but, unless detected by the central vision, the objects detected with peripheral vision will remain rather blurry.

Numerous studies examining team sports indicate that visual abilities and the ability to detect information in the periphery are important for successful performance [3, 6, 7]. This is especially the case in team sports that require object manipulation and the ability to locate, track, and respond to the object or the opponent under time constraints [8]. In team sports requiring object manipulation (e.g., basketball, soccer), objects and personnel in the visual environment that are relevant (e.g., teammates, opponents, ball) can either be scanned with foveal vision, allowing for detailed information processing of single locations, or be monitored with peripheral vision, allowing for simultaneous information processing of multiple locations [9]. In fact, athletes often need to divide their visual focus between the central and peripheral fields to achieve optimal performance [10]. Moreover, success frequently relies on the ability to react quickly to peripheral visual information [11, 12, 13]. As an example, in their review of perceptual-cognitive skill, Hodges et al. [8] classified peripheral vision as one of the functional visual skill important for elite performance.

In general, peripheral vision has been assessed by having participants detect stimuli at various distances relative to a centrally fixed position [2, 8]. During such tasks, the visual field (n°), accuracy, and reaction time of the stimuli presented in the PVF is usually measured [8]. This aspect of visual perception assesses the athlete's ability to react to stimuli both in the central and peripheral visual areas without having to turn their head. Peripheral vision is often assessed with automated computer systems such as Vienna Test System (Schufried GmbH, Moedling Austria) [14] or Nike Sensory Stations [15, 16, 17].

Research investigating peripheral vision has received less attention than central vision. However, numerous studies have examined aspects of peripheral vision within v handball [18],

badminton [19], football [20], soccer [21, 22, 23], basketball [24], running [25], field hockey [26], soccer referees [27] and among children [28]. However, investigating visual perception in athletes with different level of experience is still not thoroughly researched. On one hand, some reports show that PVF in athletes are better than nonathletes, and athletes with higher level of experience have better parameters than less experienced [29, 30]. According to study of Vanttinen et al. [23] comparing 10-year-old and 16-year-old groups of soccer player simple reaction time in the older group was 10.2% faster, peripheral awareness 22.3% higher, and eye-hand-foot coordination 37.5% better. Similar outcomes was achieved in Vogel and Hale's study. The results of this study support the conclusion that children who have participated in organized athletic programs tend score better than children with limited athletic backgrounds [28].

Zwierko [6] examined the vision of handball players and nonathletes. In study PP was used to show that athletes have significantly quicker peripheral reactions compared to non-athletes. The results indicated that handball players were able to react more quickly to stimuli presented in the peripheral field compared to non-athletes. However, other measures of peripheral perception ability such as field of vision and accuracy of reactions showed no significant differences between handball players and non-athletes. Similar results was presented in Kalberer et al. [20] study. No significant difference was found among players of skilled and non-skilled positions on peripheral awareness task performance. This study also shown that visual reaction time to a peripheral stimulus was faster in skilled football players than non-skilled football players. Also, Balakova et al. [21] have shown no differences between talented and less talented youth soccer players among overall field of vision and reaction time. The study by Zwierko et al. [31] used various VTS tests to compare volleyball players and non-athletes. The results demonstrated that volleyball players had shorter total reaction times compared to non-athletes in response to visual stimuli appearing in both the central and peripheral field of vision, and had shorter pre-motor reaction times in terms of both simple and choice reaction.

The aim of this study was to compare peripheral perception (reaction time to stimuli in the peripheral field of vision) of basketball players on different level of experience and monitor the development perceptual skills in basketball-playing groups during adolescence. The study involved 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.

Material and Methods

One hundred sixty five basketball players participated in the study. Participants were divided in one of three different experience groups: a group of expert players (E, n = 42), group of under 19 (U19, n = 33); group of under 15 (U15, n = 90).

All the participants were male. The participants from the expert group (E) were experienced basketball players between 18.4 and 37 years of age who volunteered to take part in the study (mean age = 26.1 years; SD = 4.8). The participants had at least 10 years of experience (mean = 15.7 years, SD = 5.06). All the players from group E were members of four teams that competed in the 1st and 2nd highest-ranking basketball league in Poland. The under 19 group (U19) comprised 33 male basketball players aged 17.2 ± 0.8 with mean training years M = 6.46, SD = 0.99. Third group was under 15 (U15) with an average age of 14.09 years (training years M = 3.11, SD = 0.84). The players represented all positions in the team (i.e. guards, forwards and the center). All the players had normal or corrected-to-normal vision. None of them were informed about the purpose of the experiment. Informed consent was provided before participation and the experiment was conducted with the ethical approval of the lead institution.

The PP test assessed peripheral perception and central tracking using Vienna Test System by Schufried GmbH [14]. During the test, each participant focused his attention on the centre of her field of vision while computer software generated 40 stimuli (20 stimuli from the right side and 20 from the left side) on the side panels of the device. The participant performed a tracking task, at the same time responding to visual stimuli in the peripheral field of vision. To assess peripheral vision, the assignment involved watching vertical lines that blinked and showed up in the outer edges of the visual field at various intervals. When a player recognized the lines, he reacted by pressing a foot pedal. The results of the test also provided information about divided attention. Tracking was controlled by steering a "view-finder" with knobs, so that the "view-finder" tied in with a red point on the screen. It was verified that the "view-finder" was correctly positioned by detecting a flicker at the point. During the examination, the players' head (and eye) positions were assessed with respect to the observation field. The following variables were recorded: total field of vision, viewing angle of the left and right eye, tracking deviation, number of correct reactions (the participant pressed a pedal when a flashing line appeared on the right or left panel of the device), number of incorrect reactions (the number of times the participant pressed the pedal when no stimulus appeared), the number of omitted responses (numbers of times the participant failed to press the pedal when a stimulus appeared) and median reaction time – left and right stimuli (the time of correct responses to a stimulus).

Basic descriptive statistics were applied to describe the collected data The statistics included mean (M), standard deviation (SD), minimum value (min), maximum value (max) and median (Me). To confirm the homogeneity of variance, Bartlett's test was performed. Depending on the test result, one-way analysis of variance (ANOVA) or the Kruskal-Wallis test was performed.

Results

Statistical significant differences were observed between groups regarding most of the analysed variables, especially those related to peripheral vision (i.e. field of vision, visual angle left and right). Group E had better PP test results than U15 group with regard to field of vision ($p < 0.001$), visual angle left ($p < 0.001$), visual angle right ($p < 0.05$), median reaction time of left eye ($p < 0.001$), median reaction of right eye ($p < 0.001$), median reaction both eyes ($p < 0.001$). U19 group also was significantly better than U15 in field of vision ($p < 0.001$), visual angle left ($p < 0.001$) and right ($p < 0.001$), median reaction time left ($p < 0.001$), right ($p < 0.01$) and both eyes ($p < 0.001$), tracking deviation ($p < 0.05$), number of correct reaction left ($p < 0.05$). No statistically significant differences were observed between E and U19 groups, although arithmetical means of these variables were higher in U19 group than in E group. No statistically significant differences were observed between all three groups in number of correct reaction right (Tab. 1, Fig. 1-3).

Table 1. The results of the regression analysis for static stability factors in FR

	M + SD			Me			Max-min		
	expert	U19	U15	expert	U19	U15	expert	U19	U15
Visual angle/ left (o)	87.97 ± 3.27	88.16 ± 2.4	85.29 ± 2.88	87.1	88.3	85.5	95.6-82.2	93-82	92.8-77.9
Visual angle/ right (o)	86.88 ± 3.52	87.9 ± 2.21	84.97 ± 2.81	86.6	87.8	85.3	97.9-81.7	93.4-83.9	91-79.1
Field of vision (o)	174.85 ± 6.08	176.07 ± 3.89	170.26 ± 5.14	173.2	176	170.25	191.7-165.7	186.4-167.5	182.8-160.2
Tracking deviation	13.05 ± 5.34	10.75 ± 2.03	11.98 ± 2.47	10.6	10.2	11.5	29.5-8.1	17.5-8.4	19.7-8.2
Number of correct reaction/ right (n)	18.32 ± 2.14	18.36 ± 2.03	18 ± 1.98	19	19	18	20-12	20-13	20-11
Number of correct reaction/ left (n)	18.56 ± 1.98	18.94 ± 1.46	17.98 ± 1.68	19	20	18	20-12	20-16	20-13
Number of incorrect reactions (n)	1.83 ± 1.88	1.15 ± 1.18	1.64 ± 1.57	2	1	2	9 - 0	4-0	7-0
Median reaction time/ left (s)	0.57 ± 0.06	0.6 ± 0.07	0.66±0.07	0.571	0.59	0.644	0.71-0.471	0.745-0.453	0.876-0.478
Median reaction time/ right (s)	0.564 ± 0.043	0.59 ± 0.07	0.65 ± 0.08	0.562	0.579	0.634	0.68-0.478	0.713-0.42	0.823-0.499
Median both eyes	0.564 ± 0.046	0.59 ± 0.06	0.65 ± 0.07	0.563	0.6	0.641	0.69-0.481	0.712-0.432	0.810-0.486
Omitted reaction	2.44 ± 3.1	2.7 ± 2.93	3.91 ± 2.85	1	2	3	11-0	9-0	13-0

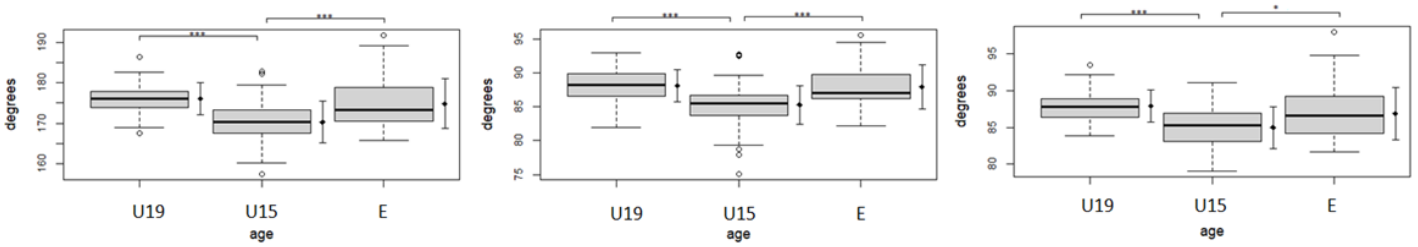


Figure 1. Field of vision, field of vision of left visual angle, field of vision of right visual angle in three groups

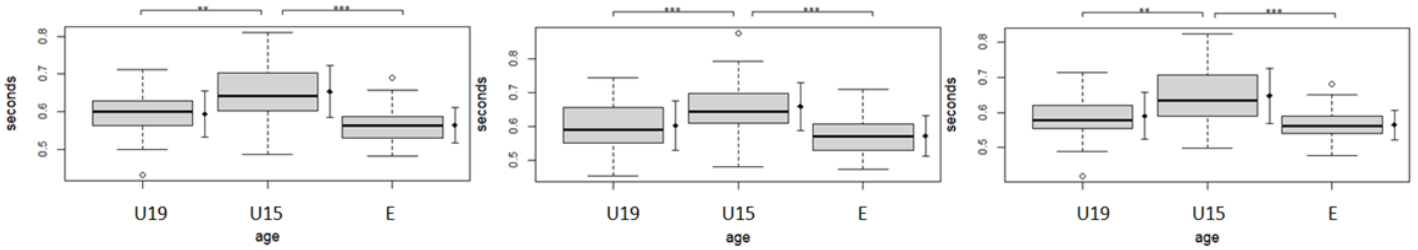


Figure 2. Visual reaction time, visual reaction time in left peripheral vision, visual reaction time in right peripheral vision

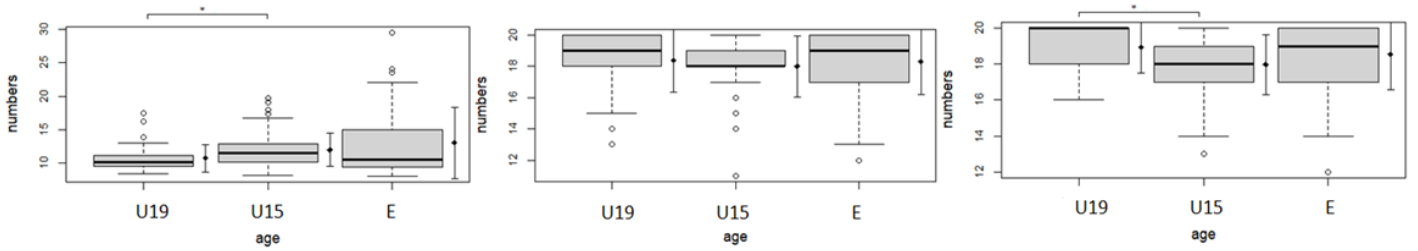


Figure 3. Tracking deviation, number of correct reaction in left peripheral vision, number of correct reaction in right peripheral vision

Discussion

The aim of the study was to compare peripheral perception between basketball players in different level of experience. This study was conducted to investigate the effects of experience and skill level on peripheral perception in basketball players, which could have important implications for training and performance in the sport. Understanding any differences in peripheral perception between players at different levels of experience could also inform coaching strategies and help to identify areas where players may benefit from additional training. Research using Vienna Test System (VTS) has so far been conducted among athletes form different sports disciplines including badminton, running, volleyball, handball, wrestling, taekwon-do and bas-

ketball [6, 18, 19, 24, 25, 31, 32]. The study compare groups of different level of experience, so far researcher mainly analysed experienced and nonathletes groups.

In many sports situations, like in team sports, processing of information from the peripheral visual field is a beneficial element to successful performance [7]. Basketball execute sequences of movements under time pressure. These motor reactions occur mainly automatically due to extended daily practice, suggesting that visual skills related to the sports may be related to this learning process.

Consistent with previous research [18, 27, 33, 34], the results from this study indicate that the more experienced athletes had faster peripheral reaction times compared to the less experienced athletes. Specifically, the most experienced (E group) and the moderately experienced (U19 group) had faster reaction times compared to the lower experienced (U15 group). Also Schumacher and colleagues [15] found additional training effects in group of soccer players on peripheral reaction and peripheral reaction left. No significant differences were found between test and retest for other variables (peripheral reaction right, visual angles right and left, tracking deviation, number of hits left and right). These findings demonstrate the ability of experts to recognize general peripheral cues to recognize relevant general peripheral cues to which less experienced players were not attuned. The accumulation of high volume of sport specific exercises may facilitate the development of perceptual expertise in basketball players. The ability and speed of recognize stimuli in peripheral vision are important factors in decision making especially in team sport and experience gathered during years of training and mass of repetitions could be causes [10, 35]. Also several studies have concluded that higher-achieving athletes are better able to detect perceptual cues, make more efficient eye movements, and perform better on measures of processing speed and attention, as compared to less accomplished athletes or non-athletes [10, 36, 37]. Especially in team sports require athletes to extract the crucial visual information from a dynamically changing environment and make the best decision on how to respond appropriately. Research has demonstrated that this form of visuospatial cognition (multiple object tracking) is enhanced in expert athletes [38, 39].

Basketball is based on reacting very quickly to the opponent's movement or ball place and it is very common that these movements start at the periphery of the visual field. It is perhaps the reason that more experienced athletes are more skilled in of motion occurring at the periphery of the visual field. Studies have found that experienced athletes can evaluate information more rapidly compared with inexperienced [40, 41]. According to Kibele [42] primed motor reactions rely on an earlier learning process in which the perception of non-consciously represented movement features is coupled with motor processes executing a fast motor response. With agree with Ando and Zwierko [18, 33] higher level of visual 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. Non- consciously and automated fast reaction also could be reason of the highest number of incorrect reactions in E group. The experiment took place in laboratory conditions which did not remind basketball court and stimuli appearing during the game. It also could be an explanation for the highest number of incorrect reaction in E group.

Further, we did not find the significant differences between all three groups in number of correct reaction left. Only significant results found between U19 and U15 groups in tracking deviation and number of correct reaction rightt. Our results are consistent with previous assumption, which suggested that process related to "visual hardware" are limited by the physical optometric properties of the visual system [43]. The term "hardware system" refers to the non-activity related mechanical and optometric aspects of the visual system, such as visual acuity, ocular health, binocular accommodations, depth perception, colour discrimination, and peripheral vision.

In the study the youngest group omitted the greatest number of stimuli. Despite of the ended development of peripheral vision number of omitted reaction was the highest in U15 group. Even fully developed to near adults level by age 7 of peripheral vision, more complex aspects of perception are problematic. This statement is confirmed by Schwebel's research [44] that children are not skilled to estimate acceleration and deceleration, they cannot consider speed or distance of the oncoming vehicles which is one of the reason of injury of pedestrian in driveways.

Other results are contrary to expectations that E group should be better than other two. Despite of less experience and years of training U19 group has wider total field of vision, as well as visual angles for the left and right eyes than E and U15 group. The U19 group yielded better results than the E group, although no statistically significant differences were observed between these groups. However, it is worth noting that the arithmetic means of the variables were higher in the U19 group compared to the E group, which is difficult to explain. Explanation may be low involvement, poor focus of attention or experiment in isolation from the specific movement elements of sports performance. Our results may suggest that systematic basketball training doesn't influence to improve field of vision. It is in line with Abernethy and Wood [45] study. Rather, the expert's advantage appears to be perceptual, related no to basic visual function but to how domain-specific visual information is interpreted and used to guide action.

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