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INTERREACTIONS OF PERIPHERAL PERCEPTION AND ABILITY OF TIME-MOVEMENT ANTICIPATION IN HIGH CLASS COMPETITIVE BADMINTON PLAYERS

Key words: peripheral perception, anticipation, badminton, Vienna Test System.

ABSTRACT

The aim of the study was to evaluate the potential of reception and processing of peripheral visual information and time-movement anticipation, and to determine the reciprocal correlations between these phenomena in high-class competitive badminton players. Nine highest class Polish badminton players, Senior National Team representatives aged 19-26 years participated in the study. Vienna Test System was applied to provide a reliable and accurate assessment of coordinative motor skills: time-movement anticipation test (ZBA) and peripheral perception (PP) test. Right upper limb dominance was accompanied by a bigger visual angle of the left eye. In spite of the left eye dominance, a shorter time of response and a higher decision accuracy was noted in exposure to right sided stimuli. Time deviation in the ZBA test is characterised by more statistically significant correlations with different indices of the PP in relation to direction deviation.

INTRODUCTION

The issue of peripheral perception (PP) and time-movement anticipation is more and more often noticed and discussed by specialists from different countries. Also in sports (particularly, competitive ones), this issue is becoming increasingly significant [1, 3, 4, 5, 11, 15, 16, 22, 23, 27]. However, no study has been conducted so far, on the above mentioned specific coordinative motor skills. The analyses performed in badminton most frequently concern physiological properties of exercise [2, 7, 10, 13, 14, 17, 18, 20].

Modern badminton involves the domination of a defensive game, which is very quick and aggressive. This requires not only an excellent

physical condition and overall coordination level, but also specific coordinative motor skills, which may be regarded as psychomotor predispositions as well (Fig. 1). Most of the predispositions presented Figure 1 are directly related to skills, which are mostly dependent on PP and time-movement anticipation.

During sports competitions, a high level of visual perception is a critical factor. It is due to human body responses, which are most effective in exposure to visual stimuli. Man communicates with the environment using his sight mainly, and a large part of the central nervous system concentrates on the analysis of visual stimuli [19]. Selection of stimuli is a characteristic aspect of perception in badminton competition. The initial processing of

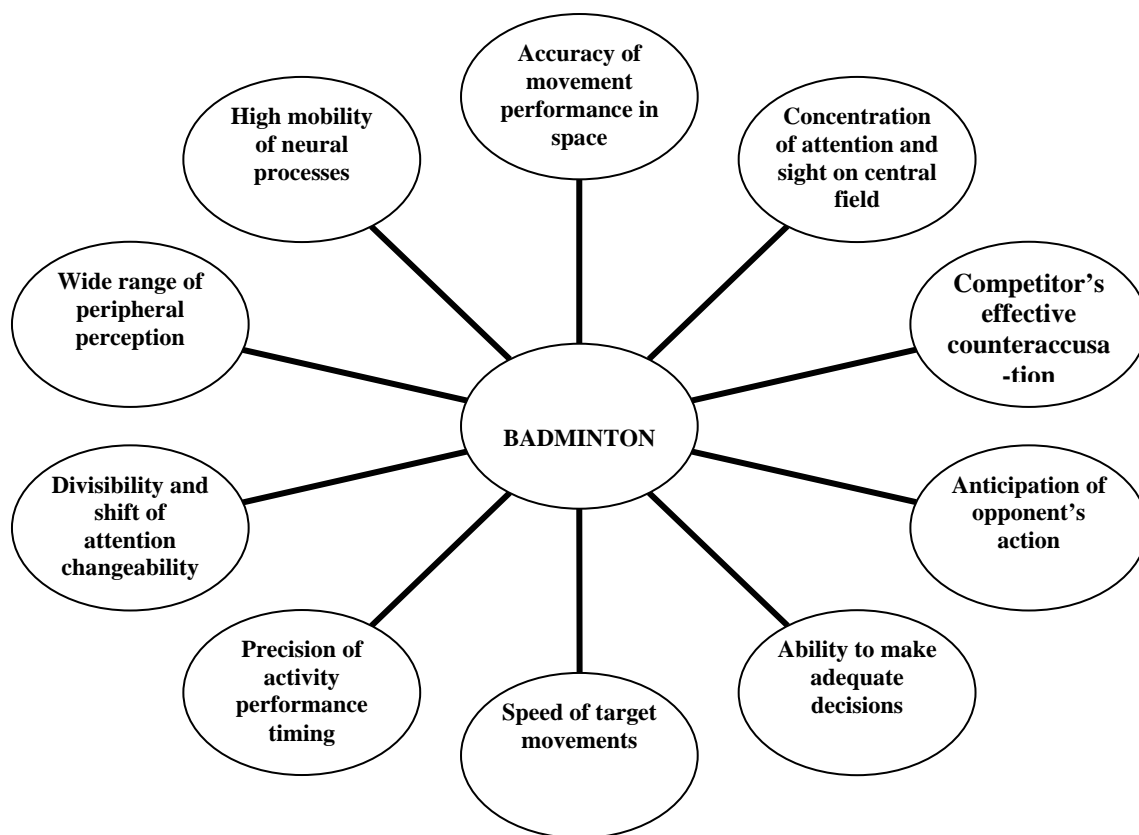


Figure 1. Specific psychomotor predispositions for badminton

visual information is usually followed by the player's selection of the most significant stimuli from a quickly changing series of short duration, to make game performance as effective as possible. Therefore, the skills of reception of the highest possible number of such stimuli, as well as the adequate interpretation of these stimuli are extremely important, yet not easy due to certain game-specific obstacles. The basic obstacles, which make precise observation difficult in badminton, include: running, acceleration, eyeball movement and speed of the shuttlecock. Due to these factors, images on the retina are unstable. It results both from the movements of objects and people (shuttlecock, the opponent) and from the continuously changing position of the competitor [9]. During a badminton match, the player's eyes perform a lot of different movements with a very high frequency to analyse the opposing player's movements and simultaneously, to track the of shuttlecock movement by subsequent placement of different parts of the image in the sharpest visual field. A tracking reflex is a natural response to the

object moving in the visual field. The information about eyeball movements is used for evaluation of the changes in this object position and facilitates anticipation of the target place and time. The brain additionally utilises earlier experience, enabling the competitors an adequate interpretation of the conditions and making quick and accurate decisions resulting from their proper actions [9, 12].

A wide range of vision seems necessary in multiple circumstances, e.g. when the opposing player strikes the shuttlecock close to the sideline. It may also affect temoral and spatial orientation due to a better control of the player's own position, the opponent's position and the approaching shuttlecock.

The role of peripheral perception, related to the conditions at the court, is equally important as that of central perception. As for the latter, its optimal utilisation is necessary as it facilitates looking for the right places to play, tracking the shuttlecock, as well as evaluation of the player's and the opposing player's speed of movements. However, due to its limited range, in most cases the

competitors make use of the “angular vision” in order to control the sidelines with simultaneous continuous central tracking while observing the opposing player. Perception of the lateral regions by turning the head in the direction of the approaching shuttlecock does increase the visual field around a given point, which decreases the risk of committing error of hitting it or receiving the out ball, but at the same time, it prolongs the reaction time and interferes with hitting technique. Moreover, due to a large head mass of an adult person (about 5.5 – 7 kg), moving it within too wide ranges in order to see a shuttlecock diminishes the risk of imbalance of the whole body.

A high level of perception skills may also indirectly contribute to the improvement of time-movement anticipation, which is a very important element of badminton competition. High class competitors playing racket sports are characterised by a high level of anticipation skill, allowing them to predict the opposing players’ actions [26]. In badminton competition winning (mainly in singles) depends to a large extent on this skill [25]. A shuttlecock moves at a very high speed, therefore very often a competitor has to anticipate hitting before it occurs.

Anticipation in badminton may be most simply defined as prediction of the forthcoming event at the court before or immediately after hitting the shuttlecock, based on certain prerequisites, and making use of this information to react adequately. There are two kinds of anticipation related to the opposing player; namely, total anticipation (an ability to predict the opposing player’s behaviour facing a given situation), and partial anticipation (predicting what the opposing player would not do) [6].

The lack of prediction and anticipation skills is believed to be one of the reasons of responding inadequately to a given situation or play [8].

A high level of this skill enables competitors to interfere with their opponents’ tactics, i.e. making the game conditions extremely difficult for them so as to hinder the opponents’ adequate responses or to reveal the drawbacks of their techniques [21].

The aim of the study was to evaluate the capability of reception and processing of visual information and the skill of time-movement anticipation, and to determine the reciprocal correlations between these phenomena in high class badminton players.

METHODS

The subjects were nine highest class Polish badminton players, Senior National Team representatives (Tab. 1). All the subjects were aged 19-26 years. Six of them were master class players and three of them – international class players. All of them were right-handed.

Table 1. Characteristics of the studied competitors

Index	Age [years]	Body mass [kg]	Body height [cm]	Training record [years]
Mean values	22.33	80.71	184.63	14.11
±SD	2.35	9.05	6.01	3.75

The study was conducted during the preparatory period of a yearly training program.

Vienna Test System (VTS) was used to define the unitary range of peripheral perception in badminton players. VTS enables a reliable and accurate assessment of coordinative motor skills [22]. The following tests were selected from the battery of VTS tests: 1. time-movement anticipation test (ZBA) (H. Bauer G. Guttman M. Leodolter M., Leodolter U.); 2. peripheral perception test (PP); (G. Schuhfried, J. Prieler, W. Bauer).

The evaluation involved:

- temporal anticipation with time deviation median as the index (error of time estimation recorded as time difference in seconds);
- spatial anticipation with direction deviation median as an estimated variable (error of place estimation is recorded as a deviation from the proper target, expressed in pixels);
- linear tracking deviation in pixels;
- left and right vision angle in degrees;
- number of accurate responses;
- number of false responses;
- response time in seconds.

According to the authors, the coefficient of test reliability (Cronbach's Alpha) for the variables: “right and left visual angle” are: $r = 0.97$ and $r = 0.96$ for “tracking deviation”. An arithmetic mean, median, standard deviation (SD), variability coefficient and Pearson’s linear correlation were used for statistical analysis.

RESULTS

A total visual field in humans consists of the right and left eye visual fields. The interpretation and analysis of this study results indicate that the range of vision in badminton players is relatively large, amounting on average to 172.9°. The range of vision in the left eye (89.9°) is almost 7° wider than that of the right eye (82.8°). The maximal value of the total visual field for both eyes, noted in the studied badminton players was as high as 179.7° with a relatively low (3%) inter-individual coefficient of variation (Tab. 2).

most frequently overlooked the tracked point in the central visual field ($r = 0.64$), which was confirmed by higher values of linear tracking.

The second test, studying the skill of time-movement anticipation allowed us to obtain information in the form of two variables: time deviation median and direction deviation mediana. The mean value of time estimation error was noted at the level of 0.79 ± 0.30 s, while the mean value of deviation from the right aim was 57.5 ± 20.57 pixels with relatively high variability coefficients reaching 38% for the first index and 36% for the second index. The obtained results let us conclude that the

Table 2. The mean values of the indices obtained from peripheral perception (PP) test, carried out in high class badminton players

Variables	Mean values	±SD	Maximal value	Minimal value	CV%
Visual field [°]	172.9	4.45	179.7	166.5	3%
Vision angle – left eye [°]	89.99	2.78	96.5	87.5	3%
Vision angle – right eye [°]	82.86	2.81	89	79	3%
The number of adequate responses – left side stimuli	15.8	2.53	19.5	12	16%
The number of adequate responses – right side stimuli	18.3	1.48	20	15	8%
Omitted responses	5.8	3.42	13	2	59%
Response time median – left side stimuli [s]	0.66	0.07	0.82	0.58	10%
Response time median – right side stimuli [s]	0.66	0.05	0.69	0.52	8%
Response time median right/left side stimuli [s]	0.66	0.04	0.69	0.57	6%

All the subjects were characterized by right-handedness and left eye dominance. The phenomenon of crossed laterality was observed. In all the competitors, the range of vision in the eye at the non dominant body side was much wider than that of the right eye. The maximal and minimal vision angle were 96.5°; 87.5° and 89°; 79° for the left and right eye, respectively. The vision angle of the left eye negatively correlated with age at the level $r = -0.43$. As for the visual field range, it is of note that despite the clear left eye dominance, more correct responses to right-sided stimuli (18.3) and a shorter time of response to these stimuli (0.63 s) were observed. The differences in the time of response to the stimuli in the left and right visual field however, seemed statistically insignificant.

The speed of response both to left- and right-sided stimuli increased with the competitors' age ($r = -0.41$; $r = -0.69$); however, older competitors

studied group of competitors is differentiated both in terms of time anticipation and direction estimation.

The analysis of both test results (PP and ZBA) showed a significant correlation between their basic indices (Tab. 3). Definitely more significant correlations were noted in the case of time deviation, which negatively correlated with the visual field ($r = -0.82$), vision angle of the left eye ($r = -0.67$), the median of time of the response to left side stimuli $r = -0.73$) and the right eye vision angle ($r = -0.45$).

Significant positive correlations of both variables of time-movement anticipation was in turn noted (for time and direction deviation, respectively) in relation to: tracking deviations ($r = 0.60$; $r = 0.59$) and correct responses to left-side stimuli ($r = 0.43$; $r = 0.55$).

Table 3. Correlations between basic indices of peripheral perception test (PP) and time – movement anticipation test (ZBA), performed in high class badminton players

Index	Time deviation (s)	Direction deviation (pixels)
Visual field [°]	-0.82	-0.27
Vision angle left [°]	-0.67	-0.02
Vision angle right [°]	-0.45	-0.28
Tracking deviation	0.60	0.59
Number of correct responses – left side stimuli	0.43	0.55
Number of correct responses – right side stimuli	-0.06	0.08
Number of incorrect responses	0.89	0.15
Response time median – left side stimuli [s]	-0.70	-0.61
Response time median – right side stimuli [s]	-0.30	-0.72
Response time median right/left side stimuli [s]	-0.59	-0.78

As for the variables obtained from both tests, the most significant correlations were noted between time deviation, visual field ($r = -0.82$) and the number of incorrect responses ($r = -0.89$). It was shown that the wider the range of peripheral perception, the greater the reliability in time determination, and the greater the time error, the more incorrect responses in PP test.

DISCUSSION

The problem of peripheral perception in sports is very rarely analysed. However in tennis, which is one of the sports most related to badminton, perception and anticipation are mentioned as the first most important components, which have to be in harmony so as to enable master-level performance during competition [24]. In badminton, the skills are of particular importance due to the fact that all the components of tennis competition at the highest level may be well applied in badminton, as during matches, the actions require even a higher speed, accuracy and precision of movement.

Peripheral perception or tracking what happens around with simultaneous attention focusing on the most important central point was analysed in sports by Zwierko [27], who also used the VST tests. The author compared the range of perception and the capability of quick perception of stimuli in the peripheral regions in handball players and non-training individuals. She showed that visual function of peripheral perception did not

significantly differ in the studied groups. As compared to the non-training controls, handball players were not characterized by a higher level of PP skill, as for the range (width, visual field) and the adequacy of responses to visual stimuli. Conversely, the athletes were characterized by a definitely shorter time of response to the stimuli occurring in the peripheral visual field. Moreover, it was noted, when interpreting Zwierko's results, that the total range of vision was smaller by 2° than that of badminton players (170.95 ± 9.15). A slightly bigger (90.11 ± 6.32) and a definitely narrower range of vision was observed for the left and right eye, respectively (80.84 ± 6.69).

A study of basketball players was also conducted using VST tests. Its results showed that the total range of vision (169.1°), as well as different angles for the left (89.8°) and right eye (79.3°) turned out to be smaller than in the studied cohort of badminton players. The times of response to stimuli, both for the right and left visual field were similar in competitors of both sports. The number of adequate responses to right-sided stimuli was bigger as compared with that of badminton players. In both groups, despite a 100% left eye dominance, more adequate responses and a shorter response time were noted in the right visual field [21]. This might be due to the fact that the tests were performed with the dominant right hand. A stimulus perceived with the right eye is processed in the left brain hemisphere, which simultaneously controls function of the right side of the body, making the response quick and accurate. A stimulus

perceived with the left eye is, in turn, analysed and processed in the right hemisphere. Probably the time necessary for the stimulus to be transmitted to the left hemisphere, coordinating function of the right hand (used to perform the test), increases the overall time of response to the stimuli in the right visual field. At the same time, a high prevalence of stimuli interferes with the response to some of them.

Kohmura and Yoshigi [16] prove that specific training methods result in an increase of oculomotor function level in baseball players, already after four weeks of training. The measurement of visual skills during the pre- and post-training period showed statistically significant results at the level of $p < 0.01$. The study results confirm that a specific training, both of perception and visual skills contributes to the improvement of oculomotor potential of the competitors, and thus, to the improvement of the level of their sports performance.

The game of badminton is a real test of coordinative oculomotor skills. This sport requires a greater visual involvement than everyday routines such as reading or working with a computer. If the shuttlecock is seen too late, this inadequate visual assessment, followed by a wrong decision causes there is virtually little chance for the competitor to win. An aggressive technique of the opposing player results in eye strain, impairment of attention focusing, perception and the capability of evaluation of the distance, as well as the speed of the opposing player and the shuttlecock.

Unrestrained and accurate tracking of the moving object with both eyes is not particularly difficult when only one object is tracked. It is definitely more difficult to control several elements at the same time. Although tracking the shuttlecock until it touches the racquet is necessary for adequate hitting, it does not prove useful in competition. During a match, two additional factors should be considered to perform the most successful hit: watching the opponent and the court line.

The problem of peripheral perception range and the ability to focus the sight in the central field, as well as the effect of those phenomena on time-movement anticipation level seems a very crucial and underestimated problem in sports. The elements of oculomotor coordination formation should therefore be included in sports training to prepare competitors for optimum level perfor-

mance, when the shuttlecock is hit with a high frequency, force and speed. The correct perception of a greater number of different informative events affects the quality and facilitates anticipation of the opposing player's actions and thus, making faster and more effective decisions on the court.

Therefore a successful training program for badminton players should include the means and methods shaping both peripheral perception and time-movement anticipation. Diagnosing these important, specific coordinative motor skills should be considered both in a rational prognostication of the competitor's development (training effect control) and in the process of selection (mainly in master class athletes).

A detailed interpretation of the study results indicates that the phenomenon of crossed laterality explicitly occurred nearly in all the badminton players. The dominance of the right upper limb is accompanied by a greater angle of vision in the left eye. Despite the left eye domination, a shorter response time and a higher accuracy of decision making was observed in exposure to right-sided stimuli.

Conversely, the analysis of both tests (PP and ZBA) results showed a significant correlation between their basic indices. The SD in time-movement anticipation was characterized by more statistically significant correlations with different PP test indices in relation to direction deviation.

The highest correlations of the variables obtained from both tests were noted between the direction deviation, the visual field and the number of incorrect responses. It was found that the wider the PP range, the higher the accuracy of time anticipation is; and the greater the time error, the more incorrect responses occur. The above findings may be useful for the right choice and selection of badminton players in high-level competition.

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