THE RELATIONSHIP BETWEEN THE SPEED OF MOTOR REACTION AND SHORT-DISTANCE RUNS AND THE EFFECTIVENESS OF PLAY IN DEFENCE AND OFFENSE IN BASKETBALL

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Abstract:

In this paper a study of basketball players' psychomotor efficiency is presented. The psychomotor efficiency was tested in a simulated play in defence, which permitted the measurement of the speed of anticipatory and orientation reacting, as well as anticipatory ability. The movement efficiency was measured by timing the 5, 10, and 30 m runs. The relationships between the tested factors and effectiveness of play in offense and defence were examined. Nineteen highly skilled basketball players of an average age of 15.3 years participated in the study. It was found that the tested psychomotor efficiency factors correlated with the effectiveness of actual play in defence. The study has also shown that the speed of short distance runs (5, 10, 30 m sprint) plays an important role in offense. The following coefficients were obtained: correlation between the effectiveness of play in defence and the speed of anticipatory reacting (0.48), anticipation (-0.50), the index of psychomotor efficiency (-0.53) and between the effectiveness in offense and times of 5 m (0.39), 10 m (0.46) and 30 m (0.47) runs.

Key words: *basketball, simulated play in defence, psychomotor efficiency, locomotion efficiency, correlations, effectiveness of play*

Introduction

The nature of motor behaviour in basketball

Basketball is a game which requires a high speed of displacement on the court, keen orientation of location of the ball, the opponents and co-players, and the anticipation of ball flight and players' movements. In the course of a game, competitors perform cyclic and acyclic movements and a combination of these movements in different directions. Players continually react to the changes in the location of the ball and the other players (Wyżnikiewicz-Kopp, 1977; Apostolidis, Nassis, Bolatoglou, & Geladas 2004).

Anticipation, specific to motor activity in basketball, consists of predicting the motor actions of the team and individual behaviour. The motor activity of the players is aimed at overcoming the opponent with the full co-operation of individual competitors and the team as a whole. In view of the diversity and variability of motor stimuli, basketball demands particular cognitive abilities to be able to adjust one's internal states to diverse situations, or to think tactically.

Finding relationships between the speed of movements, the psychomotor efficiency factors connected with motor reaction, as well as an expert assessment of the course of the game should improve the accuracy, reliability and objectivity of assessing a competitor's aptitude regarding his/her further training.

We have set the hypothesis that the players who are faster in motor reaction and have a higher ability of anticipation are more effective in defence play, while those players who run faster at short distances demonstrate a higher effectiveness in offense. The hypothesis will be verified on the basis of Pearson's correlation between the tested factors and the effectiveness in an actual game. Those of the tested factors correlating stronger with sporting effectiveness will be used to work out a research method which will be permanently used in the training process for the systematic diagnosis of special skills in basketball and for the selection of players at different levels of training.

The aim of this research was to analyse the relationship between the speed of short distance runs (5, 10, 30 m) and the speed of motor reaction and anticipation with the effectiveness of play in offense and defence in a younger junior basketball team.

Metods

Sample of subjects

Nineteen highly skilled basketball players of an average age of 15.3 years and with a period of special training in basketball of 5.16 years, competing for admission to the School of Sporting Excellence in Basketball participated in the study. The players played basketball in 5 regional basketball centres and were selected by their coaches as the best players in the centres. According to that the tested group had the character of a convenience sample.

The sample represented the population of highly skilled younger junior basketball players.

Testing the psychomotor efficiency in simulated play in defence

The simulatory method for testing the psychomotor efficiency of play in defence, developed by Huciński, Łapszo and Tymański (2002), was used in this study. The method was based on the application of the psychomotor efficiency timer constructed by Łapszo (2002).

By virtue of its simulatory nature, this method differs considerably from court tests currently used to investigate basketball skills (Ulatowski, 1992; Dežman, Trninić, & Dizdar, 2001). Dežman, Trninić and Dizdar (2001) tested the expert model system designed to improve basketball players' orientation in different positions and roles in the game. Psychomotor performance in basketball is usually tested by means of a computer technique or psychological tests. Tenenbaum and colleagues (Tenenbaum, Stewart, & Sheath, 1999) tested target detection and attentional flexibility. A tested player scanned a computerised display and decided whether an exceptional target was absent or present. Hoffman, Bar-Eli and Tenenbaum (1999) investigated the Profile of Mood States and analysed the relationship between the mood and performance in a professional basketball team.

The psychomotor efficiency timer applied in this study consisted of a computer, a controller, and a measurement station. A regular computer-type laptop was used in the experiment. The computer served to programme the measuring tests and to store the data. The controller constituted a prototype microprocessor device which enabled controlling the lamps, speakers, sensors (modular parts of the timer) and measuring the movements times with precision to 1 ms.

The measurement station (Figure 1) for this study consisted of eight boards of visual (lamps) and audio stimuli (sound signals), one board, which had lamps showing the start and end of the test, eight tactile sensors, and signs marking the starting position.

The measurement station was set up on half of the basketball court, whereas the stimuli boards and the stands with the sensors were placed in the positions typical of play in offense used by (circumferential) competitors (Figure 1, sensors 1, 2, 3, 4) and players under the basket (Figure 1, sensors 5, 6, 7, 8). The starting position for the subject (defender) being tested was directly under the basket.

In the presented method the speed of anticipatory (Ta) and orientation (To) movements specific to defensive play were measured. In basketball one can differentiate the "strong" side (that side of the court where the ball is) from the "weak" side (where the ball is not). When the lamps on the boards light up, this means that the ball has been passed from the "strong" to the "weak" side. The flight of the ball is discretely simulated by the

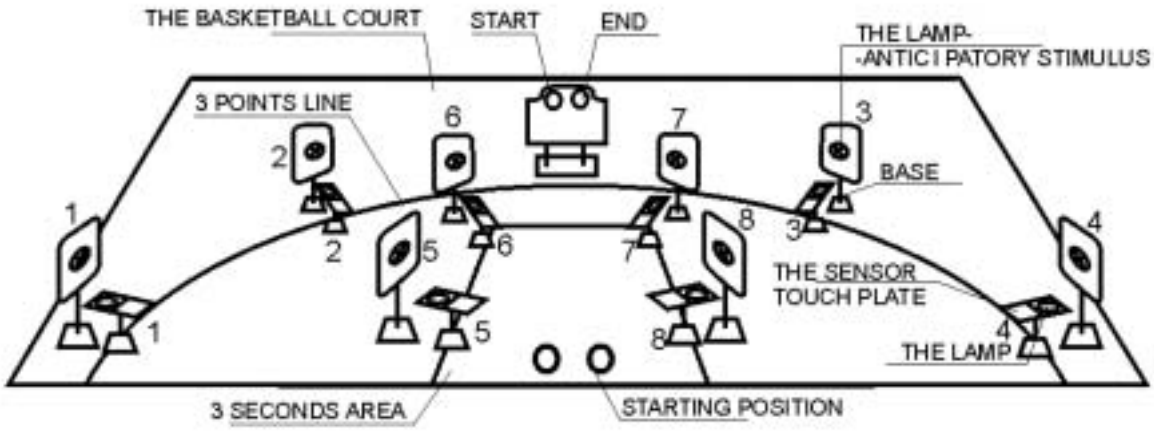

Figure 1. The measurement station for testing the psychomotor efficiency in basketball.

sequential switching on the lamps on the boards and then in the sensors. The ball flight paths were simulated by creating constant pairs of lamps (lamp on a board - lamp in a sensor): 1-7, 2-8, 3-5, 4-6, 5-3, 6-4, 7-1, and 8-2. The anticipatory movements were stimulated by the lamps on the boards (anticipatory stimuli), while the orientation movements by the lamps in the sensors (orientation stimuli). The speed of a single movement was measured by time elapsing from the instant of switching on the lamp in the sensor (orientation stimuli) till touching the sensor. The shorter the time, the higher the movement speed. The pause between the lighting up of the board (anticipatory stimuli) and sensor (orientation stimuli) lamps was 1 second.

In anticipatory conditions the players could anticipate the simulated ball flight on the basis of the memorised (learned) constant pairs of lamps (lamp on a board - lamp in a sensor). In orientation conditions the players had to recognise where the activated sensor is located and run towards it as fast as possible. Each kind of test required eight different movements to be performed. In both tests the subject started the run from the starting position (under the basket) and touched with the further hand the sensors located at a height of 140 cm and then returned to the starting position. The average speed for these eight movements was recorded. The order of movements was different in each test. The anticipatory movements test was repeated 7 times, while the orientation movements test was repeated 3 times.

The average results of the last two anticipatory and orientation tests were treated as the final speed for anticipatory (Ta) and orientation reaction (To).

The relative increase in the speed of the studied movements as a result of anticipation of the simulated ball flight was treated as the index of anticipation (Ia). It was calculated on the basis of the following formula (Łapszo, 1997):

$$Ia = (To - Ta)/ To \quad (1)$$

where Ia denotes the index of anticipation.

For a comprehensive assessment of the psychomotor efficiency the psychomotor efficiency index (Ipe) was also calculated using the following formula (Łapszo, 2002b):

$$Ipe = Ia *10/ (Ta+To). \quad (2)$$

Measurement of short distance runs speed[1]

A typical and important skill in basketball is the ability to run as fast as possible towards the ball or an opponent. The speed of a sprint at a short distance is a useful measure of this ability: it can tell us much about the player's movement efficiency (Huciński, 1996).

In the present study the movement efficiency was assessed by measuring the running speed at a 5, 10 and 30 m distance. The photocell timing system was used in the research. The system was a prototype device constructed at the Technical University in Warsaw. The photocells worked on infra-red light and enabled reading the times with an accuracy to 0.001 seconds. The subjects ran the distance of 30 m three times, while the photocells marked the time at 5, 10 and 30 m distance. The first photocell was 0.5 m and the others 1.5 m above the track level. The best results for each distance were used for analysis.

Ranking of players based on play

The technical and tactical skills of the subjects were estimated by a panel of coaches from the Polish Basketball Federation (PBF) during actual play. The test game was played in the presence of the public, and the aim of the participants was to qualify for the School of Sporting Excellence in Basketball (the training centre of the Polish national younger junior team). Each subject played for 20 minutes. The coaches awarded one point for every positive action in offense and defence, but subtracted points for negative actions. The number of points obtained separately for play in offense and defence reflected the effectiveness of the tested players in offense and defence and were used by each coach to rank the tested players from the most to the least effective in offense and defence. Two separate final ranking lists, one related to play in offense (Ra), the other one to play in defence (Rd), were drawn up on the basis of an average position of the tested players on the coaches' ranking lists of effectiveness in offense and defence.

Data processing method

The data was recorded in the text format on a computer disk. The data were then converted to the program Statistica 6.0 by means of which they were processed. The program was used to calculate the descriptive statistics, examine the normality of distribution on the basis of Kologomorov-Smirnov test and to calculate the Pearson's correlation coefficients between the tested factors.

Results

The descriptive statistics of results of the tests applied in the research, obtained for the examined group, are presented in Table 1.

[1] The research into the speed of 5, 10, 30 m distance was carried out on the commission of the Polish Basketball Federation by Dr Jerzy Wielkoszynski.

Table 1. The descriptive statistics of anticipatory (Ta) and orientation (To) movements speed [s], indices of anticipation (Ia) and psychomotor efficiency (Ipe) and times [s] of runs at distances of 5, 10 and 30 meters (Run 5 m, 10 m, 30 m) for the group tested

	Ta [s]	To [s]	Ia	Ipe	Run 5m [s]	Run 10 m [s]	Run 30 m [s]
M	1.175	1.772	0.337	1.164	1.035	1.814	4.470
SD	0.157	0.128	0.07	0.303	0.046	0.108	0.292
Min	0.881	1.483	0.173	0.514	0.956	1.639	4.14
Max	1.523	2.022	0.48	1.863	1.139	2.097	5.403
Sk	0.426	-0.036	-0.449	-0.002	0.661	0.768	1.862
Ku	0.072	0.547	1.088	0.974	0.854	1.542	4.935

Legend: M - mean, SD – standard deviation, Min - minimum, Max - maximum, Sk - skewness, Ku - kurtosis

The Kologomorov-Smirnov test has shown that for all the tested factors the distribution of probability density was normal. We have found a relatively large positive skewness of the distribution for the factor Run 30 m (1.862). Kurtosis of the distribution was positive for all the tested factors and the largest (4.935) for factor Run 30 m. It indicates that for this factor the degree of peakedness of distribution is much smaller than in the normal distribution.

The coefficients of Pearson's correlation between all the tested factors were calculated. The results of this research are presented in the form of a matrix (Table 2). We have found statistically significant correlation between the speed of anticipatory movements (Ta), the index of anticipation (Ia) and psychomotor efficiency (Ipe) and the ranking of effectiveness in defence (Rd), and between the speed of run at 10 m and 30 m distance and the ranking of effectiveness in offense (Ra). The findings positively verified the hypothesis set in the introductory section with respect to the speed of anticipatory motor reaction and anticipation. The hypothesis was also positively verified with respect to the speed of run at 10 m and 30 m distance. The study has also shown a strong correlation of the index of psychomotor efficiency Ipe with the index of anticipation Ia and the speed of anticipatory movements Ta. A strong correlation between speeds of runs at all the tested distances was also found.

Table 2. The matrix of correlation between the ranking of effectiveness in play in offense (Ra) and defence (Rd), anticipatory (Ta) and orientation (To) movements speed, indices of anticipation (Ia) and psychomotor efficiency (Ipe), speeds of runs (Run 5, 10, 30 m)

Factors	Rd	Ra	Ta	To	Ia	Ipe	Run 5 m	Run 10 m	Run 30 m
Ra	1	0.23	0.06	-0.02	-0.08	-0.06	0.39	0.46*	0.47*
Rd		1	0.48*	0.16	-0.50*	-0.53*	0.23	0.14	0.17
Ta			1	0.62*	-0.84*	-0.95*	0.38	0.37	0.56*
To				1	-0.09	-0.36	0.49*	0.54*	0.63*
Ia					1	0.96*	-0.15	-0.10	-0.28
Ipe						1	-0.26	-0.25	-0.43
Run 5 m							1	0.91*	0.86*
Run 10 m								1	0.90*

* statistically significant correlation coefficients for $p<0.05$.

Discussion and conclusions

The presented study has shown a relatively strong correlation between the effectiveness of play in defence (Rd) and the speed of anticipatory movements (Ta) and a weak and statistically insignificant correlation between Rd and the speed of orientation movements (To). It is probably caused by individual differences in the ability to memorise the anticipatory schema (pairs of lamps on the boards and in the sensors) and in the speed and accuracy of processing (associative and imaginative process) of information stored in the schema. The anticipatory schema and the information processing that occur in anticipatory reaction make this kind of reacting more difficult than orientation reaction, in which the orientation of target location in space is mainly based on perceptual processes.

The index of anticipation Ia applied in this study was higher for those players who were more effective in defence play. The index reflects the ability of place coincident anticipation (Lapszo, 1997), i.e. the coincidence of player's movement with the anticipated spot of the ball's flight. This research is in disagreement with Meeuwsen's (1991) and Lidor's and colleagues (1998) studies. Meeuwsen showed that coincidence anticipation measured with the application of Bassin's anticipation timer does not differentiate highly and less skilled players in ball games. Lidor's team has not found any differences in the anticipation time between skilled and novice players in female handball.

We have not found a statistically significant correlation between factors Ta, Ia, Ipe and the effectiveness of offense play (Ra).

The times of the 5, 10 and 30 m runs reflect the capability of the body to accelerate in locomotion movements. We have also found a relatively strong correlation between the effectiveness of offense play (Ra) and the speed of run at the distance of 10 (46) and 30 m (47) and an insignificant correlation between Ra and speed of run at the distance of 5 m. These findings indicate that the speed of run at such distances that allow displacing players from their 'own' half of the court to the opponent's half of the court plays an important role in offense. The coefficients between Ra and Run 10 m and Run 30 m can be higher for juniors or seniors. Further research is necessary in this area. Other researchers who have tested the speed of the short distance run in basketball have focused on investigating the relationship between the speed and anaerobic capacity (Apostolidis et al., 2004) or sex differences in the speed (Greene et al., 1998).

We have introduced a complex index Ipe in the presented study to take into consideration all the tested psychomotor factors related to play in defence (Ta, To, Ia). The highest correlation coefficient (-0.53) with defence play effectiveness (Rd) was found just for this index, and therefore this index seems to be the most useful to diagnose the effectiveness of play in defence. Similar values of the correlation coefficients between the run at a distance of 10 and 30 m and the effectiveness in offense (Ra; 0.46, 0.47) indicate, that only the 10 m run (a large space is not required to take the measurements) can be used to diagnose the locomotion efficiency related to offensse. The tested group had the character of a convenience sample. The results obtained in the presented study can be generalised to highly skilled young junior basketball players.

The following conclusions with respect to highly skilled young junior basketball players can be drawn from this study:

- The simulatory method of testing specific movements in basketball is useful to assess analytically the complex psychomotor efficiency in defence.
- The speed of anticipatory movements (Ta) and anticipation (Ia) are important in defence.
- The speed of short distance runs (10, 30 m sprint) plays an important role in offense.
- Both methods of research permit an overall assessment of the psychomotor (index Ipe) and motor (speed of 10 m run) efficiency related to the effectiveness of play in defence and offense in basketball, respectively.

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RELACIJE IZMEĐU BRZINE MOTORIČKE REAKCIJE I TRČANJA NA KRATKE DIONICE S USPJEŠNOŠĆU U IGRANJU KOŠARKE U OBRANI I NAPADU

Sažetak

Uvod

U radu je predstavljeno istraživanje o psihomotornoj učinkovitosti košarkaša i njihovoj pokretljivosti na igralištu. Cilj je rada bio analizirati relacije brzine motoričke reakcije i anticipacije te brzine trčanja kratkih dionica (5, 10 i 30 m) s uspješnošću igre u obrani i napadu kod mlađih juniorskih košarkaških ekipa. Oni faktori koji će pokazati čvršće korelacije sa sportskom uspješnošću upotrijebit će se u stvaranju istraživačke metode koja bi se u procesu treninga koristila za permanentno dijagnosticiranje stanja specifičnih košarkaških znanja i vještina te za selekciju igrača na raznim razinama sportskog razvoja.

Metode

U istraživanju je sudjelovalo 19 kvalitetnih košarkaša, prosječne dobi od 15,3 godina s prosječnim sportskim stažom treniranja i igranja košarke od 5,16 godina, koji su se natjecali za prijem u Košarkašku školu vrhunskih igrača (School of Sporting Excellence in Basketball). Upotrijebljena je metoda simulacije za testiranje psihomotorne učinkovitosti igrača u obrani koja se temeljila na mjeraču psihomotornog vremena. Mjerač vremena psihomotorne učinkovitosti sastojao se od računala, kontrolera i mjerne stanice. Kontroler (prototip mikroprocesorskog uređaja) je nadzirao žarulje, zvučnike i senzore (modularni dijelovi mjerača vremena) i mjerio je vremena pokreta preciznošću od 1 milisekunde. Mjerna stanica se za potrebe ovog istraživanja sastojala od 8 semafora s vizualnim (žarulje) i zvučnim (zvučni znak) podražajima, zatim od jednog semafora sa žaruljama koje su označavale početak i završetak testa te 8 taktilnih senzora i oznake za početnu poziciju. Mjerna je stanica bila postavljena na polovini košarkaškog igrališta, dok su podražajni semafori i stalci s taktilnim senzorima bili postavljeni na pozicije tipične za protivničku igru u napadu (polukružno u odnosu na koš) kojoj se prilagođavaju pozicije obrane. Ispitanikov (braničev) polazni položaj bio je izravno ispod koša koji treba braniti. Mjerili smo brzinu anticipacijskih i orijentacijskih pokreta, specifičnih za igru u obrani košarkaša. U košarci razlikujemo „jaku" stranu napada (strana igrališta na kojoj je lopta) i „slabu" stranu napada (dio igrališta suprotan onome na kojemu je lopta). Kada zasvijetli žarulja na semaforu, to znači da je lopta dodana s jake na slabu stranu napada. Let lopte smo simulirali tako da su se sekvencijalno uključivale žarulje na semaforima, a potom i na senzorima. Liniju dodavanja smo simulirali tako da smo stvorili stalne parove žarulja (žarulja na semaforu – žarulja na senzoru). Anticipirajući pokreti bili su stimulirani žaruljama na semaforima (anticipacijski stimulansi), a orijentacijski pokreti žaruljama na senzorima (orientacijski stimulansi). Brzina pojedinačnog pokreta mjerena je vremenom koje bi proteklo od trenutka kada bi zasvijetlila žarulja na senzoru (orijentacijski podražaji) do trenutka kada bi igrač dotaknuo senzor. Kraće vrijeme značilo je veću brzinu. Razmak između paljenja žarulje na semaforu (anticipirajući podražaji) i na senzoru (orijentacijski podražaj) iznosio je 1 sekundu. U anticipirajućim uvjetima igrači su mogli predvidjeti simulirani let lopte na temelju zapamćenih (naučenih) stalnih parova žarulja (žarulja na semaforu – žarulja na senzoru). U orijentacijskim uvjetima igrači su morali uočiti gdje se nalazi aktivirani senzor i dotrčati do njega što brže. Bez obzira o kojim se uvjetima testiranja radilo, igrači su morali izvesti osam različitih pokreta. U oba testa ispitanik je počinjao kretanje s početne crte (ispod koša); dotrčao bi do senzora, postavljenoga na visini od 140 cm od poda, i morao ga je dotaknuti daljom rukom, a potom se vratiti na početni položaj. Bilježila se prosječna brzina potrebna za izvedbu tih osam kretnih struktura. Brzina anticipirajućih i orijentacijskih kretnji uporabljena je za izračunavanje indeksa anticipacije i psihomotorne učinkovitosti.

Učinkovitost kretanja po igralištu procijenjena je brzinom trčanja na 5, 10 i 30 m. Ispitanici su tri puta pretrčavali dionicu od 30 m, a fotoćelije su bilježile vrijeme na udaljenostima od 5, 10 i 30 metara. Prva je fotoćelija bila postavljena 0,5 m, a ostale 1,5 m iznad staze za trčanje. Brzina se očitavala točnošću od 0,001 sekunda. Najbolji rezultati za svaku distancu posebnu uzeti su za daljnju analizu. Tehničko-taktička znanja i vještine ispitanika procijenio je ocjenjivački sud sastavljen od trenera Poljskog košarkaškog saveza tijekom prave utakmice. Svaki je ispitanik igrao 20 minuta. Treneri su za svaku dobru akciju i u obrani i u napadu igraču dodijelili po jedan bod, no postojali su i negativni bodovi za nuspješne akcije. Ispitanike je svaki trener, sukladno danim ocjenama igre, svrstao od najuspješnijih do najmanje uspješnih. Iz pojedinačnih hijerarhijskih popisa, načinjene su dvije konačne rang-liste: jedna za igru u napadu, a druga za igru u obrani. Korelacije testiranih faktora s uspješnošću igre u napadu i u obrani je analizirana kako bi se provjerila istraživačka hipoteza.

Rezultati, rasprava i zaključak

Dobivena je statistički značajna korelacija između rangirane uspješnosti igre u obrani i sljedećih psihomotornih faktora: brzina anticipirajuće motoričke reakcije (0,48), indeksa anticipacije (-0,50) i psihomotorne učinkovitosti (-0,53). Čini se kako su ti faktori najkorisniji za dijagnozu uspješnosti igre

u obrani. Dobiveno je da su igrači brže reagirali u anticipirajućim uvjetima i da su pokazali veću sposobnost za anticipacijsku igru u obrani jer su bili uspješniji. Dobivene su statistički značajne korelacije vremena trčanja na 10 (0,46) i 30 m (0,47) s rangiranom uspješnošću igre u napadu. To upućuje na činjenicu da su igrači koji su bili brži u trčanju na udaljenosti od 10 i 30 m bili također uspješniji u svojoj igri u napadu. Približno iste vrijednosti korelacijskoga koeficijenta između vremena trčanja na 10 i 30 m i uspješnosti u napadu (0,46 vs. 0,47) pokazuju da se za dijagnosticiranje učinkovitosti kretanja po igralištu može uzeti samo brzina trčanja na 10 m (zato što ne zahtijeva veliki prostor za provedbu mjerenja). Testirana grupa igrača imala je obilježje namjernog uzorka. Dobiveni rezultati mogu se generalizirati na populaciju kvalitetnih košarkaša mlađih juniora.