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DARIUSZ MROCZEK
University School of Physical Education in Wroclaw, Poland

CHANGES IN PSYCHOMOTOR REACTIONS AND THE ACTIVITY OF CERTAIN PHYSIOLOGICAL INDICES OF VOLLEYBALL PLAYERS

Key words: volleyball, psychomotor reaction speed, move-making speed, heart rate.

ABSTRACT

The psychomotor reaction speed determines a player's ability to make decisions and act. This is related to two component: reaction time – the time between receiving the stimulus and starting the movement; and movement time – the duration of a move. The goal of the study was to describe speed abilities of volleyball players during a game in real conditions and to specify the nature of physical effort during increasing fatigue. This was possible due to precise measurements (accuracy of 0.001 s) of both elements of psychomotor reaction using the OPTOJUMP measuring apparatus, and heart rate monitoring using the POLAR TEAM SYSTEM apparatus and software. The study results showed that the average reaction time of volleyball players was 0.571 s, ranged between 0.264 and 1.055 s. The average duration of the first step was 0.296 s, with the range between 0.178 and 0.698 s. The studied players' average heart rate during the game ranged from 90 to 149 beats per minute, with min. 65 beats per minute during rest and max 199 beats per minute during maximum effort.

INTRODUCTION

The understanding and description of all mechanisms used by players during a volleyball game are impossible due to the changeable and dynamic nature of the game. Numerous laboratory tests (1, 2, 4, 5, 6, 8, 12, 14) have been conducted on players within the scope of mental and physical structure of their body. Dozens of various test methods have already been created such as psychological and stress tests as well as physiological measurements of physical effort markers in the blood or saliva. Most of these tests, however, are conducted *post factum* and in laboratory conditions, which practically does not occur during a game as there are numerous external and internal factors which cannot be repeated in a laboratory. They are related to the mental and physical effort specific to a sport, e.g. body fatigue caused by the game-specific form of movement activity or increased motivation resulting from the current score. Thus, a similar game stress cannot be achieved in simulated conditions, for example by using a cycloergometer, as the nature of effort, the pace, dynamics, motivation and attitude are completely different.

The creation of test methods which do not interfere with the body and game structure and, at the same time, are in close relation with them would enable one to obtain data bringing them closer to understanding what is yet not invented, interpreting what is yet not interpreted and drawing valuable conclusions. The proposed paper is a small step to combining real-time tests of the game, while maintaining its independence and, at the same time, estimating the costs of the players' in-game effort.

Correspondence should be addressed to: Dariusz Mroczek, Department of Team Sport Games, Player Motoricity Unit, University School of Physical Education in Wroclaw, Poland, I.J. Paderewskiego 35, 51-612 Wroclaw, Tel/fax +48 71 3473273, e-mail: Dariusz.Mroczek@awf.wroc.pl

The aim of this work was to identify the psychomotor reaction time and the nature of physical effort of volleyball players during a game, within the scope of:

a) specifying particular elements of psychomotor reaction: reaction time (latent phase) and movement time (performance phase);
b) mark the level of physical effort indicators in comparison with increasing fatigue during a game – heart rate (HR).

METHODS

The measurements were taken before the warm-up (rest), during the game and after the game from each player.

A tested player stood in the starting square on the volleyball court axis, starting from initial position (right or left leg forward), according to the diagram (Fig. 1). This stance requires the positioning of one or the other leg backward, so that the heel is always in the measurement area of the first couple of the OPTOJUMP measuring device (10 cm from the calcaneal tuber).

Reaction speed (latent phase) measurement

- Electronic time measurement starts when the light source turns on – when the light source supply switches the relay responsible for sending the impulse to the software (Fig. 1). The impulse is recorded by the OPTOJUMP software.
- Electronic time measurement stops when any of the heels moves away from the area of the first couple of OPTOJUMP system modules (Fig. 1).
- Movement time (performance phase) measurement – the tested subject runs as fast as possible towards the light source.
- Electronic time measurement starts when any of the backward heels moves away from the measurement area of the first couple of the OPTOJUMP system and the photocell stream is breached (Fig. 1 and 2).
- Electronic time measurement stops when the backward leg is placed in the measurement area of the second couple of OPTOJUMP module (first step) (Fig. 1 and 2).

Each tested subject, with appropriate foot positioning, performs (as fast as possible) a run test to the light source, which is placed on the net.

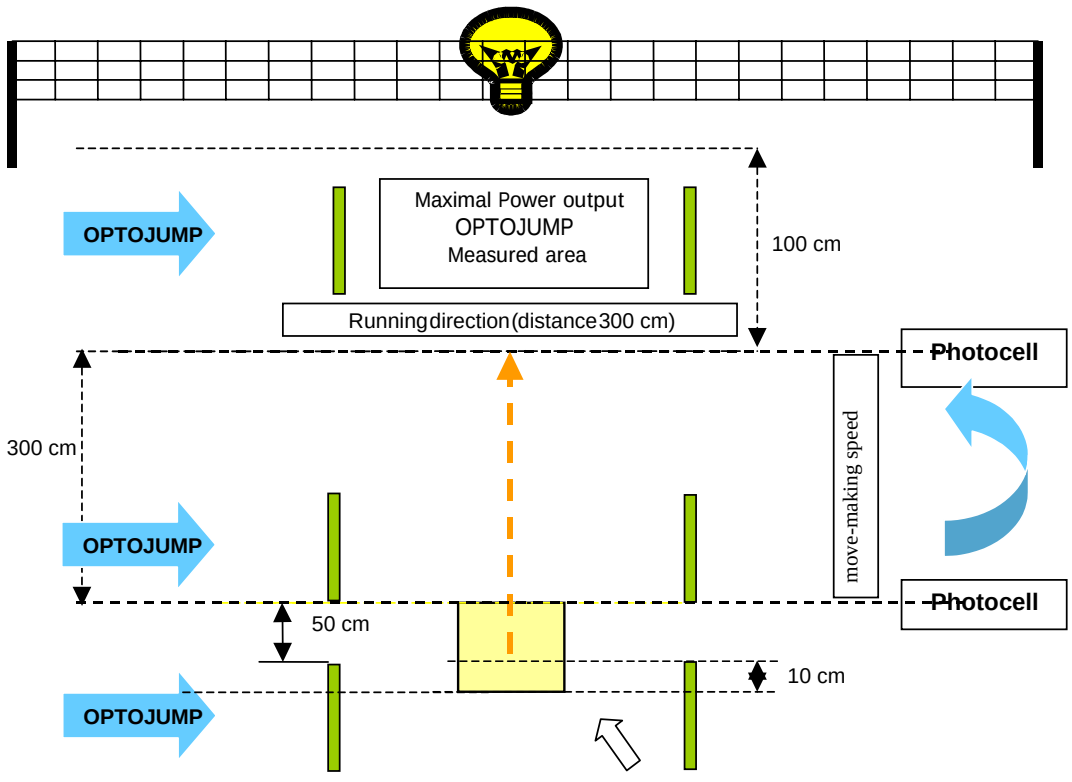

Figure 1. General research scheme

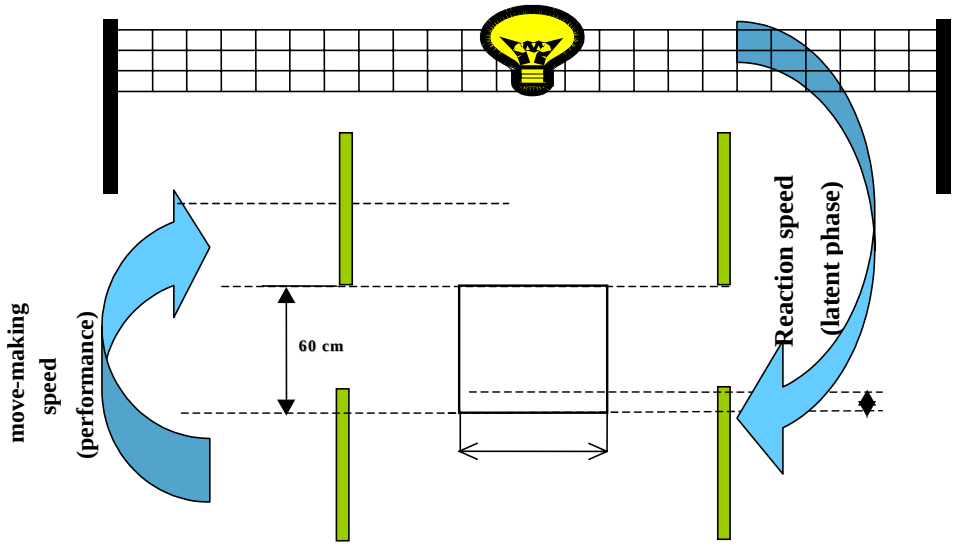

Figure 2. Reaction time (latent phase) and movement time (performance phase) measurement scheme

After each run test and a distance of 3 m, a tested subject stopped at a distance of 1 m (within the measurement area) to perform a jump test.

Measurements of physiological indicators (HR) of volleyball players

The heart rate (HR) measurements were recorded using the POLAR TEAM GAMES system sport-testers with the measurement sampling rate of 5 s. The data gathered is stored in the devices' cache memory. Each player was wearing a belt with a sensor around his trunk which did not restrict his movement during the game. It took place during a game, according to procedures described in the course of study for each tested player (libero, first center, second center, first service receiver, second service receiver and forward).

The study of physiological indicators also included the marking of blood lactate concentration (LA). However, due to the limited access to test equipment, this part of the study will be carried out in the future and the results will be published.

RESULTS

The average reaction time (latent phase) of the tested players was 0.571 s, with the range between 0.264 and 1.055 s. The average recorded movement time (first step) (performance phase) was 0.296 s, with the range between 0.178 and 0.698 s. The results of particular subjects are presented in Table 1.

When it comes to the analysis of elements of the psychomotor reaction time of players with particular functions on the court, the forward achieved the best results. His average reaction speed was 0.470 s, with the range between 0.270 and 0.644 s. This player achieved the fastest times in both psychomotor reaction elements. The libero achieved similar results. His reaction speed was 0.539 s, with the range between 0.319 and 0.661 s.

The center blocks achieved reaction time and movement time results similar to each other (worse than the forward). The average time was 0.613 and 0.568 s, correspondingly.

Serving receivers has the longest times of psychomotor reaction elements. The reaction and movement time results of the first receiver were 0.642 and 0.337 s, while the results of the second service receiver were 0.669 and 0.277 s, correspondingly.

The data concerning the substitute players were not taken into consideration, as these players were outside the court. Thus, their results would be inadequate and not comparable with the other results.

The data concerning physiological indicators of heart rate is presented in Table 2. During the game, the center block had the highest heart rate – 149 beats per minute on the average, with the range

Table 1. Reaction time (latent phase) and movement time (performance phase) distribution of volleyball players according to court positions

	Service receiver								
	resting level	set 1	set 2	set 3	set 4	min.	max	average	SD
Reaction time	0.699	0.52	0.65	1.055	0.285	0.285	1.055	0.6418	0.281165
Movement time	0.269	0.221	0.233	0.698	0.263	0.221	0.698	0.3368	0.202912
	Service receiver								
	resting level	set 1	set 2	set 3	set 4	min.	max	average	SD
Reaction time	0.628	0.477	0.843	0.86	0.536	0.477	0.86	0.669	0.175
Movement time	0.269	0.281	0.282	0.294	0.257	0.257	0.294	0.277	0.014
	Middle blocker								
	resting level	set 1	set 2	set 3	set 4	min.	max	average	SD
Reaction time	0.702	0.633	0.69	0.282	0.756	0.282	0.756	0.613	0.190
Movement time	0.312	0.336	0.344	0.257	0.612	0.257	0.612	0.372	0.138
	Middle blocker								
	resting level	set 1	set 2	set 3	set 4	min.	max	average	SD
Movement time	0.651	0.563	0.578	0.518	0.528	0.518	0.651	0.568	0.053
Movement time	0.263	0.3	0.233	0.294	0.3	0.233	0.3	0.278	0.029
	attacker								
	resting level	set 1	set 2	set 3	set 4	min.	max	average	SD
Reaction time	0.644	0.552	0.27	0.47	0.414	0.27	0.644	0.470	0.142
Movement time	0.264	0.288	0.257	0.178	0.251	0.178	0.288	0.248	0.041
	setter								
	resting level	set 1	set 2	set 3	set 4	min.	max	average	SD
Reaction time	0.495	0.651	0.562	0.512	0.561	0.495	0.651	0.556	0.061
Movement time	0.263	0.257	0.312	0.306	0.263	0.257	0.312	0.280	0.026

Table 2. Heart rate distribution of different volleyball players function during the match

initials		RN	MaW	PO	ŁP	MS	MT	MiW	MZ	MW	AB
Court function		Service receiver	Service receiver	Middle blocker	Middle blocker	libero	attacker	setter	Substitute player	Substitute player	Substitute player
Match duration	hour	01:59:15	01:55:15	01:58:00	01:57:35	01:59:15	01:58:40	01:55:15	01:50:55	01:53:20	01:54:55
Heart rate	beats	17064	16492	17594	15649	16706	15793	10380	10656	12135	14835
min HR	beats/min	90	84	89	76	86	67	65	67	75	83
average HR	beats/min	143	143	149	133	140	133	90	96	107	129
max HR	beats/min	184	170	199	176	182	166	133	147	167	168
SD	beat/min	18.4	14.9	23.4	21.9	18.4	19.4	15.8	17.1	18	12.8

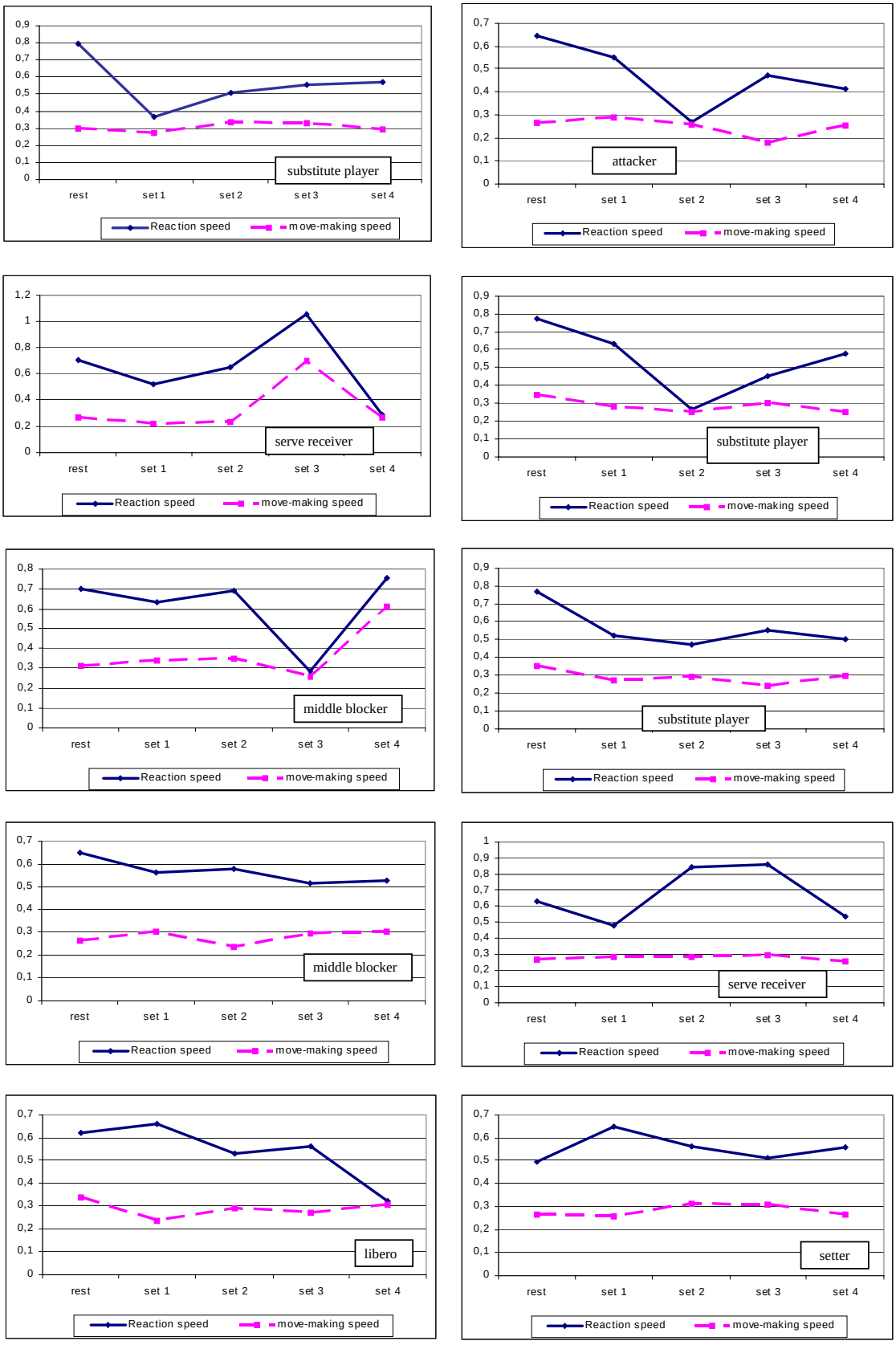

Figure 3. Diagrams of reaction time (latent phase) and movement time (performance phase) distribution of volleyball players according to their court positions during the psychomotor test

between 89 and 199 beats per minute. The service receivers had identical results – 143 beats per minute on the average. The libero's average heart rate was 140 beats per minute, with the range between 86 and 182 beats per minute. The forward had lower HR results – 133 beats per minute on the average, with the range between 76 and 176 beats per minute. The HR results of the playmaker are surprisingly low – 90 beats per minute on the average.

DISCUSSION

In modern sport games, where accuracy, precision and speed of movement decide about the win, coordination of motor abilities becomes more and more important, if not crucial. After all, apart from the necessary movement control, they determine the effectiveness of performed activities and technical and tactical actions. The importance of coordination motor abilities in relation to individual player's achievements during a game becomes a subject of numerous studies of many sport theoreticians and practitioners.

Williams (11) presents cognition as the ability comprising the "software" indicator, concerning cognitive functions related to coding and searching, as well as to the task process (decision accuracy). Meanwhile, the "hardware" part concerns physical and optometric parameters of the optical system. The first component changes (11), depending on the experience of the player, who sees and makes decisions faster. The reaction initiation time (3) ranges between 100 and 500 ms. Such differences result from many factors related to body build and composition, as well as its cognition/decision processes and experiences. Thus, it may be stated that the reaction time of the tested volleyball players (0.571 s on the average) is within the upper limit set by Chmura (3). However, these results cannot be compared with those of other authors who use measurement tests of different nature and in different sports. According to Sozański et al (9), the time of simple reaction to optical (visual) stimuli among athletes may range between 0.150 and 0.200 s. However, the author states later that there are not standards, as the results depend closely on the specific conditions. The reaction time (9) is also influenced by a number of psychological factors, e.g. concentration, hunger, sleepiness, tiredness, body temperature, motivation and attitude.

In the analysis of the gathered results of psychomotor reaction elements (Fig. 3.), depending on the players' position on the court, it may be observed that the shortest times (the best results) were achieved by the forward, who had the best jumping abilities. This player also had the lowest heart rate. The second best player in terms of psychomotor reaction speed elements was the libero, who must react quickly in the game, and move quickly around the court to receive the ball. The centers and service receivers, who were subject to comparable game stress, achieved similar results.

Summing up, it may be certainly stated that perception and reaction times play the key role in team games, particularly in volleyball, where the game dynamics and short time of reaction to the changing situation are extremely important. The ability to quickly see the incoming ball or change one's position on the court decide whether a point is scored and, in the end, the game is won.

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