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THE EFFECT OF SPECIFIC ANAEROBIC EXERCISES ON PERIPHERAL PERCEPTION IN HANDBALL PLAYERS

UČINEK SPECIFIČNIH ANAEROBNIH VAJ NA PERIFERNO ZAZNAVO PRI ROKOMETAŠIH

Abstract

In team sports, due to the great number of stimuli, perceptive skills have great significance, especially in players' decision-making processes. Recognition of the factors influencing these processes, especially in the conditions of specific physical efforts, would seem to be of crucial importance. The aim of this research was to examine changes in the level of peripheral perception induced by specific anaerobic effort in handball players (n=18) and in relation to the running efficiency of the players (time of the anaerobic running test and post exercise analysis of blood plasma lactate concentration). Peripheral perception was measured with the peripheral perception test (PP) included in the Vienna Test System (Schuhfried, Austria). To induce fatigue, a specific running test was applied. All of the players performed a specific anaerobic 10x30m test with a 20s rest interval between consecutive sprints. Most of the examined parameters of the peripheral perception test improved after the anaerobic effort (ANOVA, $p<0.05$). A higher level of running efficiency significantly improved ($p<0.05$) two results of the analyzed PP test variables (the number of correct reactions and the number of omitted reactions).

Key words: peripheral perception, anaerobic effort, handball

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Izvleček

Zaradi velikega števila dražljajev pri ekipnih športnih so zaznavne sposobnosti igralcev ključnega pomena v procesih sprejemanja odločitev. Prepoznava dejavnikov, ki vplivajo na te procese, je še posebej pomembna v pogojih specifičnih telesnih naporov. Cilj pričujoče raziskave je proučevanje sprememb v stopjah periferne zaznave, ki so posledica specifičnih anaerobnih dejavnosti rokometašev (n=18) v povezavi z učinkovitostjo teka igralcev (čas anaerobnega tekalnega testa in analize koncentracije laktatata v krvni plazmi po končani vadbi). Periferno percepcijo smo določali s testom periferne percepcije (PP), ki je del Vienna Test System (Schuhfried, Avstria). Za doseganje napora smo uporabili spcifičen tekalni test. Vsi igralci so izvajali tekalni test 10x30m z 20s počitkom med cikli šprintov. Večina opazovanih parametrov periferne percepcije se je po anaerobnem naporu izboljšala (ANOVA, $p<0.05$). Zvišan nivo tekalne učinkovitosti je statistično značilno izboljšal ($p<0.05$) dva rezultata analiziranih spremenljivk testa PP (število pravilnih reakcij in število prezrtih reakcij).

Ključne besede: periferna percepcija, anaerobni napor, rokomet

INTRODUCTION

In sport, human sight functions enable the activation of information processes associated with a player's movement in a response to changes in the environment. Some of the basic elements of sports vision include visual reaction time and peripheral vision (Planer 1994). Both these factors significantly influence the perceptual abilities of the players in team sports, although they have fundamentally different backgrounds. Peripheral vision is influenced by general functions of the human visual system. One of the fundamental functions of peripheral vision is to detect stimuli outside foveal vision and simultaneously focus attention on objects in 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 vision resolution (Curcio et al. 1990). Rod receptors are primarily located in the periphery of the retina;, these are mostly sensitive to light changes and motion. Reaction time is connected with information processes of movement control and regulation, influenced by the functions of the central nervous system and muscle effectors. Motor reaction time is the elapsed time between the presentation of a sensory stimulus and the subsequent behavioral response; thus, it has both sensory and motor characteristics (Sanders 1998).

Scientific research on visual reaction time under a homeostasis disorder can be interesting, but its results do not show unequivocal relationships between changes in reaction and physical effort. In the human body, physical exertion affects physiological functions of the circulatory, respiratory, muscular and nervous systems. The functional changes in those regions are directly connected with psychomotor performance thresholds during exercise (Etnier et al. 1997, Chodzko-Zajko 1991, Chmura et al. 2005). It is believed that typical psychomotor changes during physical effort should be distributed in a curve in the shape of an inverted-U (Tomporowski, Ellis 1986, Brisswalter et al. 1995, Chmura et al. 1994). However, the results of the research do not fully support this hypothesis. Some studies have reported a facilitating effect both during and after physical effort (McMorris, Graydon 1997, Davranche at al. 2005), whereas others have shown an impairment or no effect (e.g. Cote et. al 1992, McMorris, Keen 1994, Cian et al. 2001, Waśkiewicz 2002). Tomporowski (2003) argued that changes in information and cognitive processes induced by physical effort result from the differences in individual abilities, determined by the following factors: the type of the assignment, experience and the level of physical fitness.

Effort during team sports is often described as long-term acyclical work, with an interval character, where energy is obtained both aerobically and anaerobically. In our research, an intermittent anaerobic running test as a specific form of exercise in team sports was used. The aim of this study was to examine changes in the reaction time for the peripheral visual field induced by specific anaerobic effort in handball players. We hypothesized that reaction times for the peripheral visual field may increase after strenuous exercises. We tried to assess some parameters of hardware and software system in peripheral perception of handball players. Moreover, we tried to determine the influence of running efficiency of players on changes in the parameters of peripheral perception.

METHOD

The research material involved 18 male Polish handball players (second division) with an average age of 21.16+3.09 years. Mean body height and mass were 185.44+6.22 cm and 82.75+11.57 kg.

The research was carried out in August 2007 during preparation for the forthcoming season. The Bioethical Committee at the Medical University in Poznań, with Resolution No. 518/07 on 10th May 2007, assented to the research.

To examine peripheral perception, a peripheral perception (PP) test included in the Vienna Test System (Schuhfried, Austria) was used (Fig.1). The test consisted of two kinds of tasks conducted simultaneously: one concerning peripheral perception and another concerning the centrally-oriented tracking deviation (attention of the examined person was focused in the center of vision). The task of peripheral perception comprised of the observation of flashing perpendicular lines which, at different times, appeared in the peripheral vision. The player was to recognize the lines and to react by pressing a foot pedal. The device generated 80 impulses, where 40 appeared on the left and 40 on the right side. Tracking was controlled by steering a „view-finder" with knobs, so that the "view-finder" tied in with a red point on-screen. The proper position of the "view-finder" was confirmed by the flicker of the point. In the test, remote measurement of the position of the head (eyes) of the examined players in relation to the field of observation was performed. 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 perceived at least 50 % of the impulses. In the adaptive (individually adapted) mode, the impulses the person never observed or always observed (non-informational stimuli), constituting information noise, were not considered. The following variables were recorded: peripheral vision (n°), visual angles left/right (n°), tracking deviation (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 investigative procedure postulated realization of the PP test twice, i.e. at rest and directly after effort. Before beginning the proper test, each examined person performed a preliminary test (five times) of peripheral perception to become familiar with the format and character of the study. No tendency of improving results after completing the preliminary tests (ANOVA, p>0.05) has been observed.

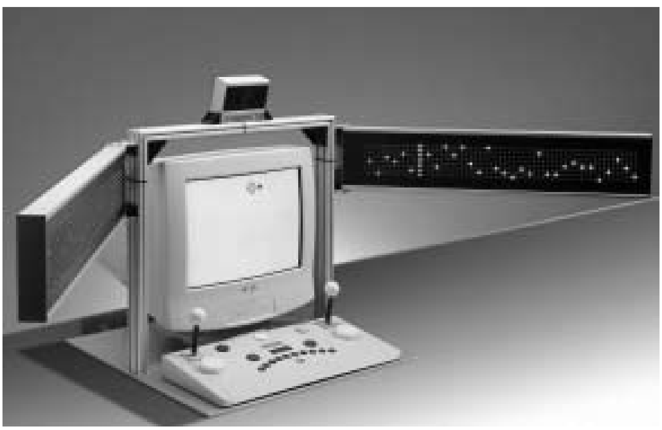

Figure 1: Station for the measurement of peripheral perception.

In this study, a specific running test was applied to induce fatigue. A player was to cover a distance of 30m at maximum speed. Pauses between intervals were 20s long. All of the players performed a specific anaerobic 10x30m test with a 20s rest interval between consecutive sprints. The tests were carried out according to the procedure described by Góralczyk et al. (2003). To estimate selected speed parameters, an LDM 300C-Sport laser diode system (Jena Optik, Jena, Germany) was used. Among the investigated group of players, their motion with reference to the distance-time relationship was recorded. The variable of the time to cover the distance 10x30m (s) was analyzed. The test was preceded by a standard warm-up. Using a heart rate monitor (Polar S610, Finland), the pulse at rest and its changes during effort was recorded. To estimate the body homeostasis, blood from the finger was sampled at rest and at the 4th minute after the end of the effort. The concentration of lactate was determined with a dr Lange Lp-20 (Lange, Germany) analytic set.

In the statistical analysis of findings, a one-factor analysis of variances (ANOVA) was used and the Pearson's coefficients of correlation was calculated.

RESULTS

The analysis of results began from the characterization of results of the 10x30m running test. The mean time obtained by examined players in the test was 5.25±0.29 s. The mean values of the heart rate at rest, after warm-up and the mean maximum rate during effort are presented in Figure 2. Analysis of variance shows that the effort significantly increased the heart rate (HR) ($F=576.16$, $p<0.0001$).

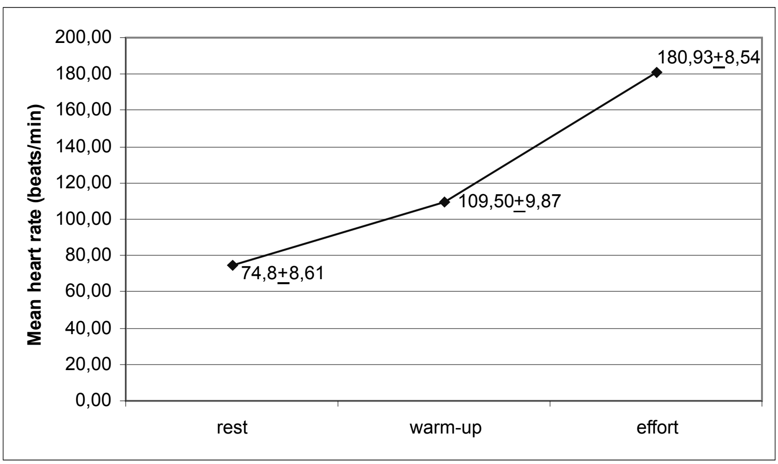

Figure 2: Mean HR values at rest, after warm-up, and the mean maximum heart rate during effort.

The effort significantly disturbed homeostasis in the bodies of the examined players, which is shown by statistically significant changes in the lactic acid levels in the blood after the performed effort ($F=762.02$, $p<0.0001$) (Figure 3).

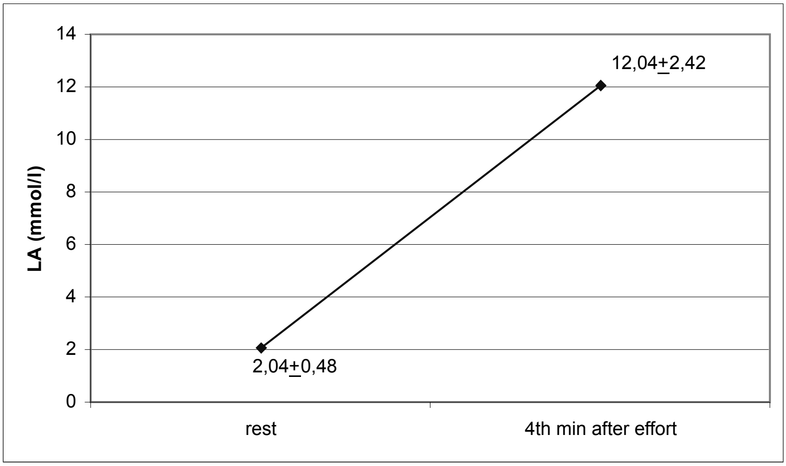

Figure 3: Mean values of the lactic acid blood levels at rest and in the 4th the minute after the end of the effort

Table 1 presents the statistical characteristics of the test results of peripheral perception at rest and after the effort. Most of the examined parameters of the peripheral perception test improved after the effort test. The number of correct reactions to stimuli appearing in the peripheral vision, both left and right-sides, increased significantly ($p<0.05$). The number of omitted reactions during the peripheral perception test decreased. The average value of this parameter at rest was 7.00±6.06 reactions omitted. After the effort, it decreased by 3.63 reactions ($F=4.62$, $p<0.039$). Mean values of the median of the reaction time were significantly shorter after the effort in comparison to the state before the effort. The reaction time to visual stimuli in peripheral vision, both right and left-sides, was shorter by 0.07 s on average ($F=4.79$, $p<0.049$) and 0.11 s ($F=8.09$, $p<0.008$), respectively.

Table 1: Statistical characteristics of the test results concerning peripheral perception at rest

Test PP	Before effort		After effort		Δ PP
	$\bar{X}$ ± SD	max-min	$\bar{X}$ ± SD	max-min	$\bar{X}$
field of vision (n°)	167.46±12.83	189-139.9	173.46± 7.72	184.9-152.5	6.00
visual angle/left (n°)	88.20±8.27	98.3-67.8	90.71±6.87	90.2-70.4	2.51
visual angle/right (n°)	79.25±7.71	89.3-62.7	82.74±4.01	90.2-77.1	3.49*
tracking deviation (pixels)	11.43±1.44	15.1-9.3	11.44±1.76	15.3-9.3	0.01
number of correct reactions/left (n)	15.56±3.65	20-7	17.81±2,51	20-12	2.25*
number of correct reactions/right (n)	17.22±3.31	20-10	18,89±2,34	20-11	1.67*
number of incorrect reactions (n)	1.65±2.19	8-0	2.65±4.38	14-0	1.00
number of omitted reactions (n)	7.00±6.06	20-0	3.37±2.94	9-0	-3.63*
median reaction time/ left (s)	0.62±0.08	0.86-0.46	0.51±0.07	0.68-0.47	-0.11**
median reaction time/right (s)	0.60±0.08	0.82-0.52	0.53±0.05	0.66-0.44	-0.07*

*p<0.05
**p<0.01

In the next part of the analysis, the influence of the physical fitness of the players on changes in the examined psychomotor parameters was examined. The level of physical fitness of the players was determined by the times of the 10x30m runs and the changes in the level of lactic acid in the blood (LA) during effort (Tab. 2). Statistically significant values of correlation coefficients were found for the time of the 10x30 m run vs. the number of correct reactions (right side), where r=-0.51, p<0.05, and the time of the run vs. the number of omitted reactions (r= 0.44, p<0.05). In either case, a higher level of running efficiency significantly influenced the improvement of results of the analyzed PP test variables. A similar relation between the changes of the lactate blood levels vs. the results of the PP test was found. However, the obtained coefficients of correlation were not statistically significant.

Table 2: Values of correlation coefficients between the changes of the PP test parameters, the time of the10x30m run, and changes in the level of the lactate in blood (LA)

Δ PP	t_{10x30m} (s)	Δ LA (mmol/l)
field of vision (n°)	-0,12	0,24
visual angle/left (n°)	-0,03	-0,24
visual angle/right (n°)	-0,14	-0,17
tracking deviation (pixels)	0,05	-0,02
number of correct reactions/left (n)	-0,31	-0,37
number of correct reactions/right (n)	-0,51*	-0,31
number of incorrect reactions (n)	-0,13	-0,24
number of omitted reactions (n)	0,44*	0,35
median reaction time/ left(s)	0,28	0,08
median reaction time/right (s)	0,13	0,15

*p<0.05DISCUSSION

Most of the examined parameters of the peripheral perception test improved after the effort. One of the parameters which improved significantly (p<0.05) was the visual angle (right-hand side), determining the range of the peripheral vision. The number of correct reactions to stimuli appearing in the peripheral vision, both from the left and right, also improved significantly (p<0.05). The number of omitted reactions to visual stimuli in the peripheral vision test decreased after effort (p<0.01). The data indicated that the intermittent running test had a positive influence on some functions of peripheral vision. A facilitating effect of effort on visual function was also observed by Millslagle et al. (2005). Their results showed a significant improvement of dynamic visual acuity (p<0.001) during cycling as the intensity of exercise increased (30%, 60% and 90% HRmax). Similar dependencies were noticed by Woods and Thomson (1995) in the contrast sensitivity function of eyes after cycling and jogging. However, several research studies showed a negative effects of physical exertion on the function of sight. For example, lshigaki (1988) proved that visual acuity and the accommodation function of the eyes deteriorated in all the cases of cycling at 20%, 50%, 80% Vo2max exercise load. Irrespective of the direction of changes in the visual function, the results indicated a significant influence of physical effort on perceptual processes at the sensory level. The explanation of this phenomenon may be a physiological function of blood flow. Lovasik and Kergoat (2004) argued that physical exertion increased the pulsatile component of blood flow in the choroids of the retina. Their concluded that the degree of perfusion of the photoreceptors necessary for vision is increased by physical exertion.

Our analysis showed an improvement ($p<0.01$) in the reaction time of the examined players to the visual stimuli in the peripheral vision. The accepted hypothesis is not confirmed. Scientific reports show that the optimum state of nervous stimulation, and a consequent high level the psychomotor efficiency, is maintained during efforts with moderate intensity (Chmura et al., 1994; Brisswalter et al., 1995; Davranche et al., 2006). Findings on the influence of high-intensity efforts on the reaction time are not as unequivocal. Some researchers show that maximum effort does not cause essential post-effort changes in the reaction time (Cote et al., 1992; McMorris et al., 2000; Waśkiewicz 2002). Others, similarly to us, who present an improvement in reaction time (shorter reaction time) with submaximum and maximum intensity effort (Davranche et al. 2005). McMorris et al. (2005), suggest that diverse effects of the level of the reaction time after maximum effort may result from the format of the applied tests. The authors noticed that the improvement of results occurred in tests consisting of the movement of the finger or the hand, or vocal response (cf. Delignieres et al., 1994; Hogervorst et al., 1996; Davranche et al., 2006). In contrast, McMorris et al. (2005) confirmed a highly statistically significant decrease in the reaction time in a psychomotor test engaging all the body of the examined individuals after intense effort on a cycloergometer.

A beneficial effect of exercise on psychomotor variables could be explained by the influence of short-term effort on the efficiency of the central nervous system, the muscles, an increase in blood pressure and an increase in conductivity in the peripheral nervous system, especially in the first phase of the effort (Astrand et al., 2003). Conversely, the disturbance of homeostasis resulting from physical effort activates compensatory mechanisms (increased concentration) (cf. Sheedy et al., 2005). It seems that it may be the key factor which determined the effect of physical effort in our study. Etnier et al.(1997) explain mechanisms of the influence of physical fitness on information and cognitive processes. One of the theories presented in that work proclaims that exercises with moderate and high intensity increase the blood flow with a simultaneous increased delivery of oxygen and glucose to the brain. Another explanation of the positive influence of physical activity on information and cognitive processes is an increased activity of some neurotransmitters. As a result of physical exercise, the brain level of catecholamine, serotonins and endorphins increases. The increased level of norepinephrine is sustained for some time and its high level is connected directly with better memory. According to Etnier et al. (1997), these beneficial effects of physical exercise on cognitive performance may be explained by long-lasting changes in brain structures resulting from the increased density of the vasculature in the cerebral cortex.

Our results show that persons with a higher level of the running efficiency (shorter time of the run) had a higher improvement in some parameters of the peripheral vision test (the number of correct reactions; right side), where $r=-0.51$, $p<0.05$, and the quantity of omitted reactions, $r=0.44$, $p<0.05$). No significant correlations between changes in the level of lactic acid vs. the examined perception parameters were found. Research by Ishigaki and Miyao (1993), Mashimo et al. (1994), or Savelsbergh et al. (2002) proves that visual functions in athletes are better in comparison to non-athletic individuals, and players with high sport abilities have better perception parameters than players with a lower sports-level. Ando et al. (2005) observed an interesting dependency between the changes in the reaction time in peripheral vision vs. the individual level of maximal oxygen uptake. On the basis of the negative correlation ($r=-0.73$, $p< 0.05$) between changes of the reaction time at rest and during the effort (240 W), and with the level of VO2 max, the authors infer that the high aerobic capacity attenuates the increase in the reaction time for the peripheral visual field during an exhaustive exercise.

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