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LEVEL OF BIATHLETE COORDINATION SKILLS OF BIATHLETES - REPRESENTATIVES OF THE SLOVAK REPUBLIC

Abstract

Coordination plays an important role in solving complex physical activities which arise during a biathlon race. We determined the level of coordination skills by measuring the time of a simple reaction to visual stimulus at rest by measuring the time response of complex reaction to visual stimuli by measuring the effect of visual-motor coordination (part of orientation skills – test Piórkowski) and by measuring the effect of visual-motor coordination (part of orientation skills – test Krzyżowy). In addition, we conducted a test of the simple and complex reaction after a short-term and long-term exercise. Among the tested sportswomen, the best results, both at rest and after exercise, have achieved twos Slovak athletes. Both results were above-average and slightly above-average. In order to develop physical coordination, we recommend biathletes to execute: the already known workout in different environmental conditions, while practicing new coordination exercises especially systematics not focusing on their maximum improvement but to gain general skills for practice while implementing them in the first part of the training.

Key words: COORDINATION SKILLS / METHODS OF COORDINATION / SKILL DEVELOPMENT.

INTRODUCTION

In professional sport there is a constant increase in performance, which necessarily requires gradual qualitative and quantitative changes in the training process. However, these changes cannot be applied without the use of scientific research findings from practice. Biathlon belongs to sports where performance is closely related to aerobic endurance and coordination of athletes (Paugschová, Hasilla, Murínová, Ondráček, & Pavlović, 2013). In modern view the former term „motor abilities" is substituted with term „motor skills", meaning motor capabilities of aperson. Term „ability" describes persisting attributes of human organism, which individualize course of its movement actions (Raczek, & Mynarski, 1992).

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On the contrary, motor skills condition organism's possibilities to effectively perform various types of assignments. Generally they are complexes of predispositions integrated through common dominating biological and movement basis, and formed by genetic and environmental factors, remaining in interactions simultaneously (Szopa, Mleczko, & Żak, 1996). Based on structural and potential differences of motor skills, they are divided into (Raczek, & Mynarski, 1992): fitness skills (energetic) - conditioned mainly by energetic-metabolic and motivation processes; coordination skills (informational) - conditioned mainly by control, regulatory and cognitive processes; and complex skills (hybrid) - determined by above factors with no clear distinction.

Coordination – perceived until now as ability to perform complex movements, shift from one complex movements to another, as well as ability to rapid realization of new movement tasks, in response to unexpected situation arising – shouldn't be considered in synthetic manner, rather it's advisable to observe it's diverse demonstrations. In the past equated with coordination „agility" is shown in presented scientific research to be strongly connected with energetic factors, in result of which agility counts among so called complex (hybrid) motor skills (Szopa, & Wątroba, 1992; Szopa, & Latinek, 1995; Spieszny, & Żak, 2001). Generally coordination is described by numerous skills, i.e. personal elements. These represent organism's possibilities within the scope of changing external conditions (change of plane, direction, motion axis). Primary factor by integration of this skill-type is their biological ground and functions of central nervous system together with sensory organs, especially the neurons capability to remember information and it's execution in process of controlling movement (Bobbert, & van Ingen Schenau, 1988; Szopa, 1995). Number of coordination skills differentiated by scientists varies from several to dozens. For sport practice, as well as for easing coordination-exercise program development important are studies leading to classification simplifying, which distinguish as main coordination motor skills following (Raczek, Mynarski, & Ljach, 1998; 2003): kinesthetic differentiation, balance, reaction speed, adaptation and reposition, orientation, uniting (linking movements), rhythm, and high frequency movement capability. Shown below is short characteristic (obtained by analyzing tests results), based on elaborations of Raczek, et al. (1998), and Juras and Waśkiewicz, (1998).

Quick response ability - allows rapid initiation of specific, aimed, short-lasting movement at a given signal, where the entire body or its part is engaged. The level of this ability is defined by time, passing since the moment signal is sent until completion of precisely described movement, what defines reaction time as well as participating body part's speed of action. Reacting on individual signals by exact movement execution is described as simple reaction. Response to individual signal can be also reaction out of options, associated with rapid signal identification, its evaluation and selection one of many possible solutions. If the physical activity is performed in complex situation, when reactions on many signals are needed, we talk about differential reaction or complex motor reaction.

Orientation skill – enables assessment of body's position and it's changes during movement of entire body (not body parts) in space and time in regard to assigned activity field (e.g. field, ring, ice hockey ground, equipment) or moving object (opponent, ball, puck), combines perception and motor activity. Spatial orientation is closely connected with time perception of movement parameters and their changes (Raczek, 1991). It depends on different types of information, however visual information plays dominant role.

Certain authors have investigated the structure of space orientation and motor adjustment computer supplemented diagnosis system (Waśkiewicz, Juras, & Raczek, 1999). Others have explored coordination abilities of competitors in biathlon with the aspect of physiological functioning and body composition. In contrast to distance track running, information on the physiological characteristics of athletes trained in cross-country running (summer) biathlon does not exist. Psotta, Svìráková, Bunc, Ìeflová, Hrásky, & Martin (2009) investigated the physiological profile of Czech elite male summer biathletes. Both, maximal aerobic power and aerobic capacity of the biathletes was 5-10 % lower than those of middle and long distance track runners found in previous studies. The study of Konttinen, Landers, & Lyytinen (2000) focused on an examination of competitive shooters' aiming process during a rifle shooting task. The results suggested that the elite shooters did not pull the trigger until they reached a sustained rifle position. In the pre-elite shooters the rifle appeared to be in a

less stable position, and their strategy was to take advantage of the first appropriate moment of steadiness without a sustained rifle position so they could pull the trigger. The present study lends support for the view that a successful aiming strategy is mainly based on sustained rifle balancing.

Directed coordination skills' training requires use of measuring equipment, enabling control of training effects. Obligatory for choice and selection is also diagnostics of coordination skills (Raczek, 1991a). For example, volleyball player with great predisposition for receiving passes fulfills hitter function, what from tactic perspective excludes him from receiving passes during game and training. Used until now coordination skills' motor tests-so called population tests–are strongly influenced by movement methods and energy factors (e.g. explosive power), (Spieszny, & Żak, 2001; Szopa, Mleczko, & Żak, 1996; Król, & Mynarski, 2012), instead laboratory measurements of psychomotor skills completed by sport psychologist require use of appropriate equipment, but even more importantly cooperation with specialized scientific research centers. Alternative to laboratory examination methods of certain coordination skills levels could be use of computer test created by Department of Theory and Methodology of Sport and Recreational Games AWF in Crakow (Klocek, Spieszny, & Szczepanik, 2002). That computer test has properties of laboratory measurements, however doesn't require use of complicated and expensive equipment – it can be run on nearly any personal computer. Competitors representing sport's top level are characterized by similar and high evolvement of adaptation mechanism of performed physical exercise. Therefore factor, which decides about the competition result, is often neuromuscular coordination. High level of this coordination decides about achieving sports success (Konttinen, Landers, & Lyytinen, 2000).

As generally known, basis for each sports discipline builds technique and the ability of its actual use during sports match. It's necessary to say, that the speed with which new movement actions (movement techniques) are acquired and their improvement is conditioned by level of predisposition to coordination skills, what establishes „genetic" basis for mastering sports technique (Czajkowski, 2004). Besides, in first training phases there is close connection between the level of coordination skills evolvement and level of sports achievements (Starosta, 1990, 2003, 2006; Szczepanik, & Szopa, 1993). It is demonstrated in fact, that competitors with high level of movement coordination master and develop sports technique and tactics more effectively, easily capture ability to disburse energy rationally and economically and also constantly enrich movement experiences (Raczek, Mynarski, & Ljach, 1998).

Biathlon as specific racing discipline demands good condition so orientation coordination skills, the balance as well as good condition sensory-motor reactions of competitors. From previous studies it can be concluded that an important role in achieving the results just have physiological mechanisms. The main goal of this research is that the use of adequate measurement instruments for assessing orientation coordination skills determine the level of numerical values of complex sensory-motor reactions at different time intervals of the Slovak national team athletes in biathlon.

METHODS

The sample

The sample was consisted of members of Slovak Republic biathlon national team (Osrblie team Slovakia). A total of seven athletes, 5 males and 2 females (age 25 ± 2,94 years, average height 178,14 ± 9,15cm, weight 68,14 ± 9,55kg) that have more than eight year of biathlon training. All subjects gave consent and voluntarily participated in the survey.

Sample of variables and tests

In actual testing, four (measured at rest) out of six proposed coordination tests were utilized and the following was taken in consideration: Simple reaction (RP) – simple reaction time measurement on visual stimulus; Complex reaction (RZ) – complex reaction time measurement on visual stimulus; Piórkowski (P) – eye-hand coordination effect measurement (part of spatial orientation skill); and Crossed (K) – eye-hand coordination effect measurement (part of spatial orientation skill). In addition, two out of four tests (simple reaction – RP, complex reaction RZ) were repeated twice, measured after short- and long-lasting exertion.

Testing of sensory-motor coordination effects with use of computer program – "PNTR" (Klocek, Spieszny, & Szczepanik, 2002).

The experimental procedure of test visual - motor coordination

Procedures are explained by Migdał, Milczarek, Pawelec, & Rosołek (1988).

Simple reaction (RP) – time measurement of simple reaction on visual stimulus. A rhythmical emission of 11 signals appearing on screen was used. The quicker was the reaction on emitted signals, the better result.

Factor: time of simple reaction

Test description: person being tested sits at desk, places her/his hands alongside computer keyboard, so that they lean loosely on the desk and lays right hand thumb on key marked "+" – on numeric keypad (left hand thumb comes on key marked "Tab"). At the moment when bright square appears in lower part of display, person being tested presses with thumb as quickly as possible the key. Signal appears in various time intervals (2-6 seconds). Time elapsed between sending signal and pressing key presents reaction speed on signal.

Measuring: program measures time interval from the moment signal appears until the moment key is pressed ("exposition time") with precision of 0.059 seconds, signal extinction follows. Result is given by median of "exposition times" after rejection of shortest and longest interval. Because measurement precision is limited by frequency at which the clock of processor is being adjusted (17/s), for accuracy of measurement at least 11 signals need to be performed at each test.

Notes: test administrator demonstrates the task in part "2.Practice test", afterwards administrator gives instructions and explanations. Immediately after the person being tested performs task in part "1.Real test". No demonstrations or explanations are before second test.

Complex reaction (RZ) – complex reaction time measurement on visual stimulus. Un rhythmical emission of 11 signals appearing on screen was used. The quicker was the reaction on emission signal, the better the result.

Factor: time of complex reaction.

Test description: person being tested sits at desk, places hands in a way, so that fingers are located above keyboard, and heels of both hands lean loosely on desk – fingers: index, middle and ring finger are laid on keys, which are active for signals appearing on display margins (left hand fingers marked "L", right hand fingers marked 'P'), both hands thumbs are laid on space key. At the moment bright square appears on display, person being tested as quickly as possible presses key accordingly to squares' position. When square appears on left margin of display one (freely chosen) key from left part of keyboard is supposed to be pressed ("QWERASDF" – specifically marked "L"). When square appears on right margin of display, key specifically marked 'P' needs to be pressed ("POIUHJKL" – from right part of keyboard). When square appears in column in the middle of display, space key needs to be pressed. Signals appear individually in constant order of position and time intervals (2-6 seconds).

Measuring: program measures time interval from the moment signal appears until the moment key is pressed ("exposition time") with precision of 0.059 seconds. Result is given by median of reaction times of eleven signals after crossing out the best and worst interval.

Notes: test administrator demonstrates the task in part "2.Practice test", afterwards administrator gives instructions and task-explanations. Person being tested performs practice task in part „2. Practice test" and immediately after performs real test in part "1.Real test". Before second test it's important to avoid any demonstrations, explanations as well as practice executing of the task.

Piórkowski (P) - computerized Piórkowski's device test on a computer – eye-hand coordination effect measurement (part of spatial orientation skill). Emission of 80 signals appearing on screen was used. Measured was time needed for test execution.

Factor: eye-hand coordination.

Test description: person being tested sits at desk, places chosen hand above keyboard, without any supporting points, stretches chosen finger in the direction of keys marked with numbers 5 and 6. At the moment when "asterisk" appears on display, person to be tested presses corresponding key as quickly as possible.

Corresponding key is the one, which marking matches the number where 'asterisk' appeared (active keys:

"1234567890" in main – alphanumeric part of keyboard). The key is to be pressed with one – chosen finger (e.g. index) of one – chosen – hand (more proficient). Following signals are appearing in constant sequence after pressing the "corresponding" key.

Measuring: program measures time elapsed from the moment of first signal appearing until the moment of pressing corresponding key after 80th (last) signal, with precision of 0.1 seconds;

Notes: test administrator demonstrates the task in part "2.Practice test", afterwards gives instructions and explains the task. Person being tested accomplishes practice task in part „2.Practice test" and immediately proceeds to real task in part "1.Real test". Before second test it's important to avoid any demonstrations, explanations as well as practice executing of the task.

Crossed test (K) – measurement of eye-hand coordination effect (component of orientation skill). Used was sequence "free" (without any assigned rhythm), measured was time in seconds needed to accomplish task (49 signals), using either hand.

Factor: eye-hand coordination.

Test description: person being tested sits at desk, places chosen hand above keyboard, without any supporting points, chosen finger stretches in the direction of keys marked with numbers 1, 2, 3, 4, 5, 6 and 7. At the moment when "asterisk" appears on display, person to be tested presses corresponding keys as quickly as possible Corresponding keys are those, which are marked with numbers matching the coordinates of "asterisk" – indicate vertical and horizontal position of "asterisk". The task is to remember both numbers (coordinates, and then press corresponding keys (in order at will). During the test keys are to be pressed with one – chosen finger (e.g. index) of one – chosen – hand (more proficient). The faster was the test execution, the better result. Next signals are projected after pressing „corresponding" keys.

Measuring: program measures time elapsed from the moment of first signal appearing until the moment of pressing corresponding key after 49th (last) sequence;

Notes: test administrator demonstrates the task in part "2.Practice test", afterwards gives instructions and explains the task. Person being tested accomplishes practice task in part "2.Practice test" and immediately proceeds to real task in part "1.Real test". Before second test it's important to avoid any demonstrations, explanations as well as practice executing of the task. Following scoring scale was created on the basis of test results conducted between teenage athletes and team games players. Statistics of girls and boys results don't show significant changes – which is standard in instance of coordination skills, therefore the scoring criteria in following tables are to be applied for both genders. Differences apply only to age of tested people, the most major is following division: age 12 and under; age 13, 14 and 15; and age 16 and up.

Assigning score worth "3" and "4" points means, that tested person reaches results close to average in her/his age group ("3" – worst than average; "4" – better than average. "5" points outcome is assigned to results considerably better (extraordinary) than median, and achieving of „6" points indicates outstanding results. Analogically "2" points outcome indicates result considerably lower than median (weak) and outcome with "1" point assigned indicates critically low result (very weak). To read scoring points assigned to outcomes conducted while testing it's important to realize, that numbers in table cells are limits of closed intervals.Below is described detailed procedure of reading the scoring points: in the magnitude of table row of corresponding test-kind, the magnitude closest to the conducted outcome needs to be find,

Procedure used in this study by tests for reaction speed (simple and complex–other ones likewise) is following:

- if test outcome is lower or equal with founded value, number of points in column header, where founded value is located, is to be read,

Example 1:

- - reaction time of simple reaction measured by testing 19-year old was 0.24 seconds;
- - in table (1) the outcome fits in the row of simple reaction in interval 0.23-0.25 seconds, accordingly for achieved reaction time are 3 points to be assigned

Example 2:

- reaction time of complex reaction measured by 20-year old was 0.35 seconds;
- in table 1 outcome fits in the row of complex reaction in interval 0.34-0.37 seconds, accordingly for achieved reaction time are 4 points to be assigned.

Table 1. Criteria for points scoring of test outcomes - age 16 and up (woman and men)

Scored points	6 points	5 points	4 points	3 points	2 points	1 point
Simple reaction time (s)	shorter than 0.18	0-19-0.21	0.22	0-23-0.25	0.26-0.27	0-28-0.30
Complex reaction time (s)	shorter than 0.25	0.26-0.33	0-34-0.37	0.38-0.44	0.45-0.48	0.49-0.56
Eye-hand coordination. Reaction time: Piórkowski (s)	shorter than 56	57-64	65-68	69-76	77-80	81-87
Eye-hand coordination Reaction time: crossed (s)	shorter than 66	67-79	80-85	86-98	99-104	105-117

Results review - 4 tests in total (accepted by description of tested people): „outstanding" – 21-24 points, „extraordinary" – 17-20 points, „above average" – 13-16 points, „average" – 9-12 points, weak" – 5-8 points and „very weak" – 1-4 points.

Results review – 2 tests in total (after exercise, accepted by description of tested female and male competitors): „outstanding" – 11-12 points, „extraordinary" – 9-10 points, „above average" – 7-8 points, „average" – 5-6 points, „weak" – 3-4 points and „very weak" – 1-2 points.

RESULTS AND DISCUSSION

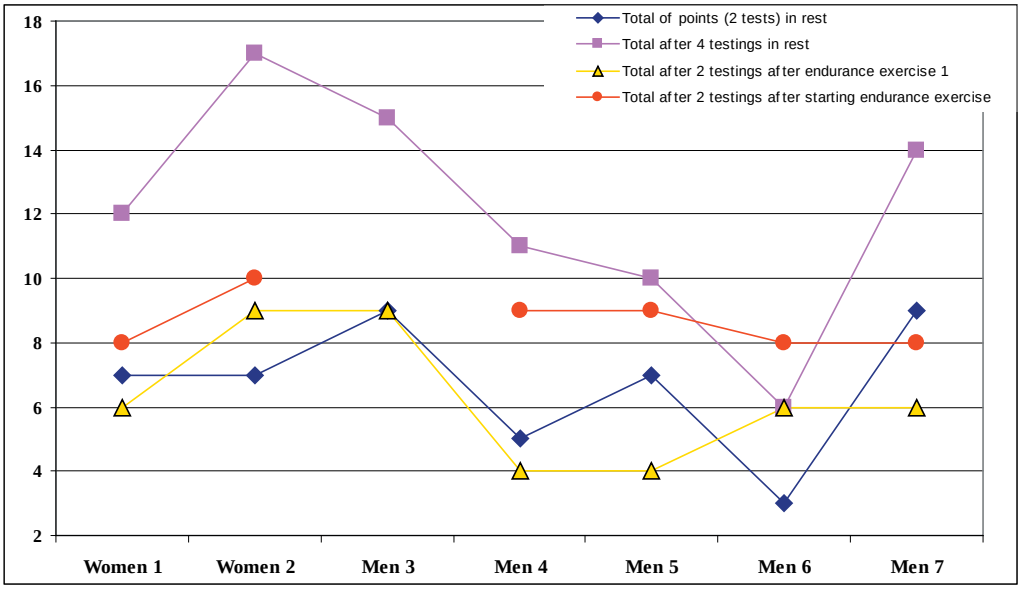
In the analyses below are presented results of tested female and male competitors (Tables 2,3 and 4). In tested group were recorded no results, what were agreed to be called "outstanding" – what doesn't count as positive, let's say from point of view on the level of sport (state representation), which tested people present.

Table 2. Characteristics of reaction times, which tested people achieved in rest and after exertion

Athletes	Simple reaction time [s]	Complex reaction time [s]	Simple reaction after endurance	Complex reaction after endurance	Simple reaction after starting	Complex reaction after starting
Women 1	0.25	0.37	0.25	0.39	0.22	0.36
Women 2	0.23	0.37	0.22	0.27	0.2	0.29
Men 1	0.2	0.36	0.21	0.34	*	*
Men 2	0.23	0.47	0.28	0.4	0.21	0.36
Men 3	0.22	0.44	0.28	0.4	0.21	0.36
Men 4	0.25	0.58	0.25	0.44	0.21	0.41
Men 5	0.21	0.34	0.24	0.4	0.23	0.29

Table 3. Characteristics of total points, which achieved tested female and male athletes in two and four testings (rest) and two testings (after exertion)

Athletes	Total of points (2 tests) in rest	Total after 4 testings in rest	Total after 2 testings after endurance exercise 1	Total after 2 testings after starting endurance exercise
Women 1	7	12	6	8
Women 2	7	17	9	10
Men 3	9	15	9	
Men 4	5	11	4	9
Men 5	7	10	4	9
Men 6	3	6	6	8
Men 7	9	14	6	8



Picture 1. Characteristics of total points, which achieved tested female and male athletes in two and four testings (rest) and two testings (after exertion)

Table 4. The achieved results coordination skills of biathletes representatives of the Slovak Republic

Athletes	Simple reaction time [s]	Score	Complex reaction time [s]	Score	Total score (2 tests) in rest	Piórkowski [s]	Score	Crossed [s]	Score	Total after 4 tests in rest	Simple reaction after endurance exercise 1	Score	Complex reaction after endurance exercise 1	Score	Total after 2 test after endurance exercise 1	Simple reaction after starting endurance exercise	Score	Complex reaction after starting endurance exercise	Score	Total after 2 testing after starting endurance exercise
W 1	0.25	3	0.37	4	7	78	2	96	3	12	0.25	3	0.39	3	6	0.22	4	0.36	4	8
W 2	0.23	3	0.37	4	7	64	5	75	5	17	0.22	4	0.27	5	9	0.2	5	0.29	5	10
M 1	0.2	5	0.36	4	9	69	3	91	3	15	0.21	5	0.34	4	9	*		*		
M 2	0.23	3	0.47	2	5	75	3	93	3	11	0.28	1	0.4	3	4	0.21	5	0.36	4	9
M 3	0.22	4	0.44	3	7	78	2	105	1	10	0.28	1	0.4	3	4	0.21	5	0.36	4	9
M 4	0.25	3	0.58	0	3	86	1	104	2	6	0.25	3	0.44	3	6	0.21	5	0.41	3	8
M 5	0.21	5	0.34	4	9	75	3	103	2	14	0.24	3	0.4	3	6	0.23	3	0.29	5	8

Based on the results obtained for the sample of competitors it is evident that the from all female competitors best results, by agreement called „extraordinary", as well in rest as after exertion types endurance 1 and starting endurance were achieved by the competitor number 2. She is the only from two female competitors, who is characterized by high level of tested coordination skills in rest as in weary condition. The other tested female competitor – marked with number 1 – presents from perspective of tested skills "average" and "above average" level.

Among all tested male competitors the best competitor was definitely no. 3, as well in weary condition as in rest he achieved results described as "extraordinary" and "above average". High results among tested competitors achieved also competitor no. 7 as well in rest as after starting endurance exercise – level "above average" and "extraordinary". However concerning could be results decline after endurance exercise 1.

Interestingly, worth mentioning results were achieved by competitors marked with numbers 4 and 5. These competitors, although achieving in rest coordination skills results „average" and „above average", in weary condition (endurance exercise 1) level of their results dropped down to "weak". This facts could indicate, that quick reaction skills are dropping in course of exercise without spirit of fighting against time and opponent – which is rather negative appearance, potentially indicating lack of full commitment at training (Czajkowski, 2004). On the other hand, when competition factor is present (starting endurance exercise) those competitors are achieving in performed tests "extraordinary" results – what speaks for their big potential in this area – definitely useful for immediate rivalry with time, opponent and shooting possibilities.

Concerning could be one tested competitor's results – marked with no. 6 – who at rest as well as weary condition places himself in terms of coordination skills only at level described as "weak" and "above average" (in case of starting endurance exercise – which is positive and mobilizing competitor's aspect at time of rivalry).

To sum up it can be said, that level of results of tested female and male competitors placed in intervals of (according to results review) groups named by agreement:

- "Outstanding" (absence of such cases) and "extraordinary" isn't of concern in relation to the level of studied coordination parameters, as well in rest as after exertion. Utilization of additional coordination practices of this kind in training is not necessary, just their maintenance on present level.
- "Above average" and "average" – is group, where in training utilization of another coordination methods in discussed field is necessary (recommended), especially at high stage of engagement in sport. Level "just average", especially in state of rivalry (weariness state), could cause lowering efficiency to quick initiation and execution of goal oriented short-lasting movement task at described moment, in which part of or whole body can participate. In case of biathlon it can have negative effect e.g. while shooting, what happens many times during competition and significantly affects competitor's result.
- "Weak" and "very weak" – should awake concerns and utilization of coordination practices should considerably increase in training work (as well in resting as in weary conditions)

Some authors have studied except coordination skills and balance and some functional aspects that influence on the result of top performance biathlete.

Sattlecker, Buchecker, Müller and Lindinger, (2014) was to examine postural balance, rifle stability and shooting performance in biathletes, analyzing the basic precision shooting skills without physical load in different performance groups. Therefore, kinematic and kinetic data from the World Cup (WC; n=8), the European Cup (EC; n=13) and a federal youth athletes' squad (n=15) were recorded on an indoor shooting range. The participants had to shoot ten 5-shot-clips without physical load. WC and EC groups showed lower body and rifle sway (mainly in cross-shooting direction) compared to youth athletes ($p<0.05$). Postural balance and gun stability predominantly in cross-shooting direction were negatively correlated to shooting performance (r = -0.33 to -0.59; $p<0.05$). The data indicate the relevance of low body and rifle sway primarily in cross-shooting direction for a successful basic biathlon standing shooting at rest.

The study of Mononen, Konttinen, Viitasalo and Era (2007) examined the relationships between

shooting accuracy and shooters' behavioral performance, i.e., postural balance and gun barrel stability, among novice rifle shooters in intra- and inter-individual levels. Postural balance and rifle stability were assessed in terms of anther-posterior (VELAP) and medy-lateral (VELML) sway velocity of the movement of center of pressure, and horizontal (DEVH) and vertical (DEVV) deviation of the aiming point. The participants (n=58) performed 30 shots in the standing position at a distance of 10 m from the target. The data showed that shooting accuracy was related to postural balance and rifle stability, but only at the inter-individual level. The correlation coefficients between shooting score and behavioral performance variables ranged from -0.29 to -0.45. The stepwise multiple regression analysis revealed that the VELML and the DEVH as independent variables accounted for 26% of the variance in the shooting score. The results also suggested that postural balance is related to the shooting accuracy both directly and indirectly through rifle stability. As the role of postural balance appeared to be important in shooting performance, the use of additional balance training programs to improve a shooter's postural skills should be encouraged.

Similar studies were carried out on the biathlon with the aim of identifying the performance of others in the performance of his score. Most often research analyzed the relationship shooter-gun-fluctuations at different time intervals (Ball, Best, & Wrigley 2003; 2003a).

In study of Ball, Best and Wrigley (2003) the relationships between body sway, aim point fluctuation and performance in rifle shooting on an inter- and intra-individual basis were examined. Six elite shooters performed 20 shots under competition conditions. Multiple regression analysis indicated that body sway was related to performance for four shooters. Also, body sway was related to aim point fluctuation for all shooters. These relationships were specific to the individual, with the strength of association, parameters of importance and time period of importance different for different shooters. Correlation analysis of significant regressions indicated that, as body sway increased, performance decreased and aim point fluctuation increased for most relationships. Another study of Ball, Best and Wrigley (2003a) reexamined this relationship on an inter-individual basis, as done in previous studies, and via intra-individual analysis, not previously examined. Five elite pistol shooters performed 20 shots similar to competition conditions. Multiple regression analysis indicated that body sway was related to performance for one shooter, aim-point fluctuation was related to performance for three shooters, and body sway was related to aim-point fluctuation for four shooters. These relationships were specific to the individual, with the strength of association and parameters of importance being different for different shooters. However, inter-individual analysis indicated that only aim-point fluctuation was related to performance. It was concluded that body sway, aim-point fluctuation, and performance are important in elite level pistol shooting, and performance errors at the elite level are individual-specific. Individual analysis should be a priority when examining elite level sports performance.

The male top-level shooters could stabilize their posture significantly better than female top-level or male national level shooters, who were, in turn, much more stable than naive shooters. The experienced shooters were able to stabilize their posture even better during the last seconds preceding the shot, whereas in naive shooters there were no significant differences when the successive windows were compared with each other (Era, Konttinen, Mehto, et al. 1996). Among the highly trained top-level shooters a miss in whole-body posture stabilization apparently seldom is a reason for a poor result

Previous researches of the techniques biathlon training indication of the complexity and impact of individual factors on the result success. Also, this research has shown that apart in addition to coordination skills have a large impact nerve-muscle reactions and very functioning of the central nervous system competitors (Laure, Bard, Otis, & Fleury, 1989; Balint, & Marton, 2011; Król, & Mynarski, 2012).

Because consistent coordination improvement of young competitors influences very favorably obtaining of technical skills in training process and achieving sport results, planned and differentiated coordination training became in contemporary sport essential and presents one of the options leading to sport mastery (Czajkowski, 2004; Raczek, 2001; Spieszny, & Żak, 2001; Starosta, 1990, 2003, 2006). It's important to remember, that improving of coordination and technical skills are two different parts of training

assignment. On one hand improving technical mastery is supposed to be oriented mainly at acquiring the skills, on the other hand narrowly comprehended coordination development is supposed to be oriented more than anything at improving functions and performance capabilities (Raczek, 1999, 2001; Czajkowski, 2004). Outlined goals of coordination training and tools used at it are supposed to emerge from requirements of given discipline, age of competitors, their training period, sports level as well as individual characteristics. Analysis of requirements-model of given sport discipline is first condition of regularity and true effectiveness (Klocek, Spieszny & Szczepanik, 2002; Raczek, 1999, Starosta 2006). In this context especially complicated appear to be team games, which require highest level of movement coordination, and accordingly spatial accuracy of movements performed in minimal time and changing conditions. Basic method of obtaining and improving coordination skills proficiency is goal-oriented directed fluctuation of exercises (mode as well as conditions of their execution). Through quantity, variability and changeability of conditions for exercise performance are motor skills enriched; stimulated are also described regulation processes. Therefore motor skills aimed at forming coordination proficiency have to meet at least one of following criteria: novelty, originality, complexity, and difficulty.

To improve coordination skills, following groups of exercises are used (Czajkowski, 2004; Fostiak, 1996): stereotype exercises, exercises improving balance keeping stationary and in motion, exercises improving skills to perform turnovers, turnarounds, falls, overthrows etc., asymmetric exercises, exercises using application of original starting positions, exercises with untypical movements conducted in their primary form, exercises using untypical conditions (e.g. different terrain, more or less difficult opponent, smaller field etc.) and exercises from other sporting disciplines.

In coordination training is important to consider and accordingly bind exercises already learned with new ones. It is to remember, that tempo of these exercises is supposed to increase in direct proportion to improvement of competitor's technical skills. At the same time, to learn big number of coordination exercises, it has to be done gradually, in compliance with „better less, and well done". One of the conditions for constant increase of coordination level and real technical action is improving symmetry of movements and their symmetry, i.e. learning them in both directions: left and right (Raczek, 1999; Waśkiewicz, Juras, & Raczek, 1999).

Coordination training is supposed to take place by repetition method with properly long rest breaks. During training units the coordination exercises should be part of first section, when competitor is rested. These trainings are better to be performed in the morning than in the afternoon, as well as before strength and endurance training (Kłodecka-Różalska, 1985; Žak, 1991) and very important is actual dosing of loads (Paugschová, Hasilla, Murínová, Ondráček, & Pavlović, 2013).

CONCLUSION

The main goal of this research is that the use of adequate measurement instruments for assessing orientation coordination skills (computer program PNTR) determines the level of numerical values of complex sensory-motor reactions at different time intervals of the Slovak national team athletes in biathlon. Considering that it was a sample of top athletes, are expected the excellent results. However, based on the results of an orientation-level coordination skills and complex sensory-motor responses can be concluded that only two athletes achieve results above the average (extraordinary), while the rest were average or even one competitor had a weaker result. The question is why is this so?

The answer can be found in the following. In addition to the of diversity in the function of the central nervous system of each competitor at which has an impact on the sensory-motor reaction, a significant effect of exercised and method of training process an orientation coordination skills and a gradual growth of load in the training.

It follows that ccritical importance has use of gradually higher and more specific training loads in accordance with rule of gradual loads growth. Implementation in practice is through use of small number repetitions of many different exercises with similar demands concerning type and way of movement regulation or through use of many repetitions

of described exercises with often changes in mode and conditions of their execution.

Increase in coordination training load can be achieved also through (Raczek, 2001):

- increase in volume and time of load duration: increase in number of repetitions, increase of exercises series, increase in number of various exercises with constant number of repetitions,
- increase in intensity of load: increase in exercise difficulty differentiation as well as changeability of conditions, exercise execution in limited timeframe, shortening of rest breaks, connecting coordination exercises with improvement of motor coordination skills.

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NIVEAU DER KOORDINATIONSFÄHIGKEIT VON BIATHLONSPORTLER INNEN AUS DEM SLOWAKISCHEN NATIONALTEAM

Zusammenfassung

Koordination spielt eine wichtige Rolle in der komplexen körperlichen Aktivität, die während eines Biathlon-Rennensausgeführt wird. Festgestellt wurde dasNiveau der Koordinationsfähigkeit durch Messung einer einfachen Reaktion auf einen visuellen Stimulus im Ruhezustand; durch Messung der Antwortzeit einer komplexen Reaktion auf visuelle Stimuli, indem der Effekt der visuell-motorischen Koordination (Teil der Orientierungsfähigkeit - *Piórkowski*-Test) gemessen wird; und durch Messung des Effekts der visuell-motorischen Koordination (Teil der Orientierungsfähigkeit – *Krzyżowy*-Test). Außerdem wurde ein Test der einfachen und komplexen Reaktion nach kurzzeitiger und langzeitiger Übung durchgeführt. Unter den getesteten Sportlerinnen wurden die besten Ergebnisse im Ruhezustand und nach Übungen von zwei Sportlerinnen aus der Slowakeierreicht. Beide Ergebnisse lagen über den durchschnittlichenund etwas über den durchschnittlichen. Um körperliche Koordination zu entwickeln, wurde Biathlonsportlern empfohlen,bereitsbekannte Übungen in unterschiedlichen Umgebungsbedingungen zu betreiben, während sie neue Koordinationsübungen praktizieren, die besonders systematisch sind, da sie sich nicht auf maximale Verbesserung konzentrieren, sondern auf denErwerb einer allgemeinen Übungsfähigkeit, die im ersten Teil des Trainingsangewendet wird.

Schlüsselwörter: KOORDINATIONSFÄHIGKEIT / KOORDINATIONSMETHODEN / FÄHIGKEITSENTWICKLUNG

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