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Prediction of coordination performance in ice-hockey players based on the structure of coordination capacities
Predicţia indicilor de coordonare la jucătorii de hochei pe gheaţă în baza structurii capacităţilor coordinative

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Abstract

Background. In ontogenesis, ice-hockey lays specific requirements on the level of coordination capacities. The development of coordination capacities differs from the one of conditional capacities, while individual peculiarities of sportsmen should not be omitted.

Aims. An important role is played by the hierarchy of coordination prerequisites in the structure of sport performance. Several remarks are made concerning the issues of the structure of coordination capacities.

Methods. Possibilities of prediction of coordination performance in ice-hockey in 11-15-year-old players were analysed. The research was carried out on a set of selected 283 pupils (11-year-olds=63, 12-year-olds=57, 13-year-olds=56, 14-year-olds=57, 15-year-olds=50) from sport classes within the Slovak Republic specializing in ice-hockey. Coordination performance was observed using 7 motor criteria by Hirtz. Individual performances in coordination tests were transformed into points based on the 5-grade coordination standard for ice-hockey and figured in one test value, which presents an overall level of coordination performance (predictant "Y").

Dependence and share of individual coordination criteria to the overall coordination performance were disclosed using the technique of multiple correlation and regression analysis. The selection of three most valid coordination (predictors "$X_{(T1-T7)}$") criteria into prediction equations of coordination performance was performed using forward stepwise regression.

Results. The most significant coordination capacities in hockey in ontogenesis are: rhythmic capacity, spatial orientation and temporal parameters estimation. The structure of the above mentioned capacities is invariable in boys aged 11 and 12 years. At the age of 13, the share of spatial orientation capacity is transferred to complex motor reaction speed. At the age of 14 to 15, the stability of rhythmic and spatial orientation capacities is proved true. The share of significance of temporal parameter estimation at the age of 14 is transferred to dynamic balance and at the age of 15, to kinesthetic-differentiation capacity of legs. In players aged 11 to 15 years, we are able to predict the overall coordination performance based on the three selected criteria with a rather high reliability (62.64-72.77%) and low error (1.523-1.973).

Conclusions. The designed calculations can facilitate talent identification, as well as the reduction of specific tests of coordination capacities.

Keywords: ice-hockey, coordination capacities, sport performance, structure, prediction, regression analysis, correlation analysis, boys.

Rezumat

Premize. În ontogeneză, hocheiul pe gheaţă presupune anumite cerinţe la nivelul capacităţilor de coordonare. Dezvoltarea capacităţilor de coordonare diferă de cea a capacităţilor condiţionale, fără a neglija însă particularităţile individuale ale sportivilor.

Obiective. În structura performanţei sportive un rol imporant îl are ierarhia premizelor de coordonare. Intenţia noastră a fost să menţionăm câteva observaţii privind problematica structurii capacităţilor de coordonare.

Metode. Au fost analizate posibilităţile de predicţie a indicilor de coordonare în hocheiul pe gheaţă la băieţi de 11-15 ani. Cercetarea s-a desfăşurat pe un lot de 283 de elevi (11 ani – 63, 12 ani – 57, 13 ani – 56, 14 ani – 57, 15 ani – 50) selectat din clase de sport din Republica Slovacă, specializate în practicarea hocheiului pe gheaţă. Indicii de coordonare au fost observaţi utilizând 7 criterii motrice după Hirtz. Performanţele individuale la testele de coordonare au fost transformate în puncte, pe baza standardului de coordonare cu 5 grade pentru hocheiul pe gheaţă şi s-a elaborat o valoare de test care prezintă un nivel general al indicelui de coordonare (predictivul „Y").

Dependenţa şi ponderea criteriilor de coordonare individuală cu indicii generali de coordonare au fost identificate folosind tehnici de corelare multiplă şi de analiza regresiei. Selectarea celor mai valide trei criterii de coordonare (predictorii „$X_{(T1-T7)}$") în ecuaţii de predicţie a indicilor de coordonare s-a efectuat utilizând regresia pas cu pas.

Rezultate. În ontogeneză capacităţile coordinative cele mai semnificative în hochei sunt: ritmul, orientarea în spaţiu şi estimarea parametrilor temporali. Structura capacităţilor menţionate mai sus este invariabilă la băieţii de 11 şi 12 ani. La vârsta de

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13 ani, capacitatea de orientare în spaţiu este transferată vitezei de reacţie. La vârsta de 14 până la 15 ani se dovedeşte adevărată stabilitatea capacităţilor ritmice şi de orientare în spaţiu. Parte semnificativă a estimării parametrilor temporali la vârsta de 14 ani este transferată echilibrului dinamic, iar la vârsta de 15 ani la capacitatea de diferenţiere kinetică a picioarelor. La jucătorii cu vârste între 11 şi 15 ani, putem prezice indicii generali de coordonare pe baza celor trei criterii selectate cu o mai mare certitudine (62,64 – 72,77%) şi cu eroare scăzută (1,523 – 1,973 puncte).

Concluzii. Calculele pot facilita identificarea talentelor, precum şi reducerea testelor specifice pentru capacităţile de coordonare.

Cuvinte cheie: hochei pe gheaţă, capacităţi de coordonare, performanţă sportivă, structură, predicţie, analiză de regresiei, analiză de corelaţie, băieţi.

Introduction

One of the main possibilities for the optimization of high performance sports activity is the improvement of the selection process. Current deficiencies, which have persisted for a long time in sport selection at national and local level, make us bring attention to three requirements of a successful selection (Bocu, 2010):

a) The possibility of a differentiated treatment of students during P.E. classes, according to their individual peculiarities and biomotor potential.

b) The possibility of applying scientific selection methods.

c) The possibility of supporting the selection performed by providing optimal environmental conditions, ensuring in this way the success of the selected individuals.

Ice-hockey is an extremely dynamic sport game requiring, among others, a high level of coordination abilities. Sport experts presume that further improvement of sport performance will be done by means of an increase in the quality of technical capability of sportsmen, for which coordination abilities create inevitable prerequisites. However, the current generation of children enter the beginning of their sport career with a worse initial level of fitness, particularly coordination, when compared to the generation of 15-20 years ago. This is the consequence of marked changes in their life style – children mostly prefer sitting and passive activities. School physical education is no more able to ensure high quality physical activity in the daily programme of children. Trainers and coaches are thus compelled to start their sport preparation from a very low level.

The game performance in ice-hockey depends on a number of factors (body composition, technical, fitness and personality prerequisites). Coordination abilities play an important role in the structure of sport performance. According to Jonath & Krempel (1991), speed contributes 20%, strength – 20%, endurance – 25%, flexibility – 10% and coordination - 25%. This is why it is inevitable to pay attention to the development of coordination factors, predominantly during the sensitive periods of their development.

Šimonek (2002) determined the following sensitive periods for the development of coordination abilities:

1. Kinesthetic-differentiation (starting from 7 years)
2. Rhythmic ability (strating from 9 years)
3. Reaction speed (starting from 9 years)
4. Balance ability (starting from 9 years)
5. Spatial orientation (starting from 10 years).

The structure of coordination performance in ice-hockey draws from the knowledge of sport performance, which forms a complex system of factors (Bukač & Dovalil, 1990). These are arranged in the system and there exist mutual relations among them, which manifest themselves in the level of sport performance. The share of the components of motor potential (aerobic endurance, speed abilities, strength abilities, coordination abilities) in sport performance in ice-hockey is equal according to the evaluation elaborated by Mangi, Jokl & Dayton (1987). The training time in pupil categories is distributed as follows: 46% complex load, 20% coordination, 12% endurance and 8% speed capacities (Kostka & Wohl, 1979).

The organization of requirements, which can be imagined as a structure drawing from a multifactorial theory, shows specific features in individual sport specializations. Knowing the hierarchy of individual factors (limiting and optimum factors for sport performance), but also their certain suppleness (which is, however, limited and decreases with the growth of performance) in the structure of sport performance, emphasizes their importance from the point of view of recognition. This differentiation, however, does not ensure their utilization in practice, since they are genetically conditioned and can also be more or less affected (Duncan & Lyons, 2009).

Searching for a sport talent is a problem of diagnosis of prerequisites for the given sport activity. Specification of procedures and criteria is inevitable for unveiling the inborn prerequisites of a potential talent. In talent search it is necessary to comprehensively take into account data on health status, functional and motor prerequisites, psychic immunity, personal characteristics and other factors (Starosta, 2003). Talent selection can be divided into two mutually affecting and consequential phases: the revealing of sport talents and the prediction of their sport performance (Hofmann & Schneider, 1985).

Attempts to specify the hierarchy and changing share of individual capacities in various sports have been recorded, while some more specific capacities in relation to different kinds of sports have been picked (Bracko & Fellingham, 1997). In spite of the complexity of coordination capacities, they seem to be relatively independent prerequisites of performance control of motor activity, while the dominant role is played by heredity (Bouchard et al., 1997). In children and youth, the following relatively independent coordination capacities have been derived: reaction speed, balance, spatial orientation, kinesthetic-differentiation, rhythmic capacities, and several others. When testing basic motor prerequisites, most of coaches avoid special coordination tests. Test batteries, which are used for talent selection for sport preparation at the age of 10-11,

detect the level of conditional motor capacities, but almost completely neglect the coordination capacities of children (Moravec, 2007).

The model of the structure of coordination capacities in ice-hockey is shown in Fig. 1.

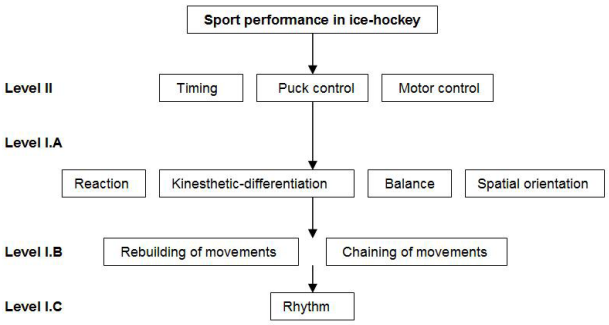

Fig. 1 – Model of the structure of coordination capacities in ice-hockey (adapted by Šimonek according to Mangi-Jokl-Dayton, 1987).

Explanations

Level II. - special coordination capacities directly limiting sport performance in ice-hockey;

Level I. - general coordination capacities:

Level I.A - coordination capacities directly limiting sport performance,

Level I.B - coordination capacities significant (can be compensated) from the point of view of sport performance;

Level I.C – less significant coordination capacities.

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The most significant coordination capacities from the point of view of the complexity of modern ice-hockey include: reaction speed, spatial orientation, dynamic balance, the ability to rebuild motor programme and chaining of movements, personal prerequisites of an ice-hockey player (sensomotor abilities and skills). The results of a questionnaire decided the ranking of the most significant factors of sport performance in ice-hockey. Among the top capacities presented by coaches were strength capacities, kinestethetic-differentiation upon manipulating the puck, spatial orientation, reaction speed and coordination capacities.

Objectives

The aim of this article is to present several remarks concerning the structure of coordination capacities and possibilities of prediction of the overall coordination performance in ice-hockey in 11-15-year-old boys. The above mentioned issues should contribute to the solving of problems of talent search and recruitment, as well as finding the tests suitable for complementing the sets of special tests for ice-hockey.

Purpose

The purpose of this study is to find out, based on measurements and calculation, what are the roles of individual coordination prerequisites in the structure of sport performance in ice-hockey in players aged 11-15.

Material and methods

The research was carried out on a set of 283 selected pupils (11-year-olds=63, 12-year-olds=57, 13-year-olds =56, 14-year-olds=57, 15-year-olds=50) from sport classes within the Slovak Republic specializing in ice-hockey.

Coordination performance was observed using 7 motor criteria by Hirtz (1985): T1 – Bench walking with 3 turns (dynamic balance), T2 – Stopping a rolling ball (complex motor reaction capacity), T3 – Maintaining motor rhythm (rhythmic capacity), T4 – Shuttle run (spatial orientation), T5 – Precision standing broad jump (kinesthetic-differentiation of legs), T6 – Precision throw (kinesthetic-differentiation of arms), T7 – Time estimation - 5s (temporal parameter estimation).

Individual performances in coordination tests were transformed into points based on the 5-grade coordination standard for ice-hockey according to Šimonek et al., (2008) and figured in one test value, which presents an overall level of coordination performance (predictant "Y").

Dependence and share of individual coordination criteria to the overall coordination performance were disclosed using the technique of multiple correlation and regression analysis. The selection of three most valid coordination (predictors "$X_{(T1-T7)}$") criteria into prediction equations of coordination performance was performed using forward stepwise regression.

The structure of coordination performance (KV) for individual age categories is presented by means of a percentage pie chart. Prediction equations include calculated coefficients of partial regression (b_{0-3}), standard errors of regression (SEy) and determinants of multiple correlations (R^2). When interpreting the results of measurements and forming conclusions, logical methods were used. Numeral processing of data was evaluated using statistical programmes Microsoft Excel and SPSS 13.0.

Results

The level of coordination capacities in the talented youth aged 11-15 is presented in Table I. Using multiple correlation and regression analysis, the hierarchic structure of coordination capacities is presented from the point of view of ontogenesis (see Table II). Three coordination capacities, by which it is possible to predict overall coordination performance with sufficient reliability, were selected using stepwise regression. Regression equations for the prediction of overall coordination performance are presented in Table 3.

In hockey players, the most significant coordination capacities in ontogenesis are: rhythmic capacity, spatial orientation and temporal parameter estimation (Table I).

The structure of the above mentioned capacities is invariable in boys aged 11 and 12 years. At the age of 13, the share of spatial orientation capacity is transferred to complex motor reaction speed. At the age of 14 to 15, the stability of rhythmic and spatial orientation capacities is proved true. The share of significance of temporal parameter estimation at the age of 14 is transferred to dynamic balance and at the age of 15, to kinesthetic-differentiation capacity of legs.

The prediction equations include the following coordination capacities: dynamic balance T1, rhythmic capacity T3, spatial-orientation T4, and temporal parameter estimation T7 (Table I). In players aged 11 to 15 years, we are able to predict the overall coordination performance based on the three selected criteria (Table II), with a rather high reliability (62.64-72.77%) and low error (1.523-1.973).

Table II

Structure of coordination capacities in 11-15-year-old ice-hockey players.

KS	Age				
	11	12	13	14	15
T1	9.72[2]	12.75	13.52	16.80[2]	17.70[2]
T2	11.10	8.21[3]	22.59[2]	4.62	15.78
T3	20.26[3]	20.84	29.63[1]	18.83	19.12[3]
T4	15.42	21.93[2]	6.49	23.38[1]	18.09[1]
T5	9.93	7.62	7.45	15.97	17.75
T6	9.79	4.48	2.36	7.39[3]	4.41
T7	24.23[1]	24.16[1]	17.96[3]	13.02	7.16

Legend

KS – coordination capacities,
T1 – dynamic balance,
T2 - complex motor reaction,
T3 - rhythmic capacity,
T4 – spatial orientation,
T5 - kinesthetic-differentiation of legs,
T6 - kinesthetic-differentiation of arms,
T7 – temporal parameter estimation.
Three coordination capacities with the highest partial share in the structure of coordination capacities,
$x^{(1-3)}$ – Three coordination capacities selected in the prediction equation with the specification of ranking.

Discussion

So far, no similar research has been found in the available literature sources. It is thus difficult to compare our results with other ones. We determined the structure of individual coordination abilities and their share in the overall coordination performance of ice-hockey players aged 11 to 15. The results show that the most significant factors of performance in ice-hockey are rhythmic capacity, spatial orientation and temporal parameter estimation**.** In players aged 11 to 15 years, prediction can be done with a rather high reliability (62.64-72.77%) and low error (1.523-1.973). Coaches can use our results to assess the level of basic coordination abilities of their players and compare it with other teams and sportsmen. We believe that our research will also help coaches in the selection process.

Conclusions

1. In the age category of 11-15 years, entropic processes of coordination capacities manifest. At the beginning, these processes are characterized by disordering and towards the end of the category, by orderliness of the system, they are dynamically changing depending on age and growth of sport performance. Within this developmental process (genesis), not only their significance, but also the arrangement of individual factors of the structure of coordination performance changes.

2. In collective sports, the three most valid coordination capacities are rhythmic capacity, spatial orientation capacity and temporal parameter estimation.

3. It is possible to predict the overall coordination performance by means of temporal parameter estimation, dynamic balance, rhythmic capacity and spatial orientation capacity.

4. The prediction of the overall coordination performance by means of the three selected coordination test criteria proved to be satisfactory.

Table I

The level of coordination performance for the observed coordination criteria in 11-15-year-old ice-hockey players.

Age	Indicators	T1 (s)	T2 (cm)	T3 (s)	T4 (s)	T5 (cm)	T6 (cm)	T7 (s)
11	Mean value	10.74	174.11	1.25	8.35	4.98	68.82	0.89
	Std. Deviation	2.42	19.70	0.72	0.76	2.21	23.85	0.56
12	Mean value	11.5	164.42	1.17	8.24	4.57	69.04	0.58
	Std. Deviation	2.36	19.62	0.88	0.98	2.22	25.69	0.43
13	Mean value	10.17	155.11	1.11	7.94	4.57	62.76	0.44
	Std. Deviation	2.22	25.21	0.67	0.92	2.30	26.69	0.37
14	Mean value	9.68	156.00	1.19	8.18	4.48	64.19	0.47
	Std. Deviation	2.10	22.19	0.69	0.96	1.92	25.23	0.40
15	Mean value	8.29	137.74	0.94	7.86	4.20	62.04	0.57
	Std. Deviation	1.89	24.86	0.71	0.73	1.77	25.81	0.52

Table III

Regression equation for the prediction of overall coordination performance in 11-15-year-old ice-hockey players.

Age	Regression equation	KV
11	$Y = 10.032 + 1.270 * X_{(T7)} + 1.250 * X_{(T1)} + 1.003 * X_{(T3)}$; SEy:1.870; R^2:62.69	20.38
12	$Y = 9.576 + 1.532 * X_{(T7)} + 1.026 * X_{(T4)} + 1.175 * X_{(T2)}$; SEy:1.946; R^2:69.17	20.63
13	$Y = 12.293 + 1.006 * X_{(T3)} + 1.154 * X_{(T2)} + 0.942 * X_{(T7)}$; SEy:1.523; R^2:72.77	22.11
14	$Y = 8.986 + 1.377 * X_{(T4)} + 1.279 * X_{(T1)} + 1.213 * X_{(T6)}$; SEy:1.973; R^2:62.64	19.68
15	$Y = 9.393 + 1.384 * X_{(T4)} + 1.287 * X_{(T1)} + 1.202 * X_{(T2)}$; SEy:1.6010; R^2:70.78	20.60

Legend

Y = predicted coordination performance (points); b_0; b_1; b_2; b_3 = regression coefficients; $X_{(T1-T7)}$ = performance in the selected coordination tests (points); SEy = regression equation error (points); R^2 = reliability of the regression equation (%); KV = overall coordination performance (points).

Practical recommendations

• It is recommended that the existing test sets of special motor capacities used for the selection of talented children into classes specializing in ice-hockey or in continuous testing of specialized sport performance should be complemented with the following test criteria: T3 – rhythmic capacity, T4 – spatial orientation capacity and T7 – temporal parameter estimation.

• When selecting coordination tests for further age categories, we recommend to be governed by the height of shares of coordination criteria in the structure of coordination performance.

Conflicts of interests

There are no conflicts of interests.

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