



Original research

Similarities and differences between sports subserving systematic talent transfer and development: The case of paddle sports

Jan Willem (AJW) Teunissen^{a,b,*,1}, Stijn (SEW) ter Welle^{a,1}, Sebastiaan (SWJ) Platvoet^a, Irene Faber^c, Johan Pion^{a,b}, Matthieu Lenoir^b

^a Institute for Sports and Exercise Studies, HAN – University of Applied Sciences, The Netherlands

^b Faculty of Medicine and Health Sciences, Department of Movement and Sports Sciences, University of Ghent, Belgium

^c Institute of Sport Science, University of Oldenburg, Germany

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ABSTRACT

Objectives: The aim of this study was to investigate similarities and differences for 18 sports toward canoe/kayak in order to identify donorsport and/or multisports, based upon a systematic analysis of the task constraints per sport that are assumed to be either crucial or less important from the coaches' viewpoint.

Design: Descriptive survey analysis.

Methods: 891 certified coaches from 19 sports valued (0–10; not important at all–very important) 15 characteristics by a questionnaire (Flemish Sports Compass) within their sport. Unique sport-profiles (discriminant analysis – DA) were constructed for 19 sports based on these characteristics. Similarities and differences between canoe/kayak and the other 18 sports were analyzed by means of MANOVAs on anthropometric, physical and motor coordination characteristics.

Results: Cross validated DA ($r_{can} = 0.660$, Wilks' $\Lambda = 0.564$, $p < 0.001$) showed that 72.1% of the canoe/kayak coaches were correctly assigned to their sport. For canoe/kayak seven characteristics were valued crucial; dynamic balance (8.51 ± 1.69), core stability (8.45 ± 2.27), pulling power (8.12 ± 1.68), speed (7.54 ± 2.07), endurance (7.27 ± 2.03), stature (6.43 ± 1.41) and rhythm (6.01 ± 3.01). Least important characteristics were: flexibility (6.16 ± 1.75), agility (4.27 ± 3.10), catching (3.90 ± 3.22), climbing (2.45 ± 3.05), jumping (1.81 ± 2.11), throwing (1.60 ± 2.24), hitting ($.94 \pm 1.77$) and kicking ($.61 \pm 1.04$).

Conclusions: This novel approach to determine important characteristics per sport makes identifying similarities and differences between sports possible. Similarities might enlarge talent-pools for possible talent transfers. Differences can help identify sports based on complementary characteristics for the construction of broad motor development programs. From this viewpoint gymnastics can serve as potential donorsport (similarities) for canoe/kayak, while handball and tennis can subserve broad development for young canoe/kayak athletes.

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Practical implications

- Assessing the contributions of generic characteristics in a sport by skilled professionals make the construction of unique sport-profiles possible.
- Cross-over options for athletes who have invested highly in a sport can be found in sports with similar profiles.

- Constructing an optimal all-round development program for young athletes is possible by identifying sports with different profiles.

1. Introduction

A successful cross-over between sports is possible when athletes are competent in comparable (transferable) elements within different sports.^{1,2} Cross-over athletes capitalize on the product of their giftedness, personal attributes and previous investment and are potentially high-performers and quick-developers (fast-tracking) in other sports.^{3,4} Athletes with a diversified sport background can be fast-tracked into a new sport, making this pathway time-

* Corresponding author.

E-mail address: JanWillem.Teunissen@HAN.nl (J.W. Teunissen).

¹ These authors contributed equally in this work.

effective in the pursuit of success in a new sport.³ Possible arguments for athletes to cross-over are; taking up a new challenge, pursuit of success when they realize they are not able to succeed in their main sport and the great possibilities appointed of becoming champions in related sports⁵. Therefore, identifying potential cross-over options can be very attractive for national governing bodies (NGB's) increasing the success-rate talent identification- and development programs by recycling talent, as they are not more effective than spontaneous cross-overs.⁴ Identifying comparable elements between sports can be beneficial for increasing the success rate of talent programs.

Cross-overs between sports are possible when the individual is able to adapt an existing movement pattern to a different set of ecological constraints.⁶ More specific, cross-overs from one sport to another are possible by interaction of an individuals' intrinsic dynamics (e.g. anthropometrics, movement skill capabilities, physical and physiological condition, perceptual and conceptual abilities, mental and cognitive skills^{7,8}) and matching environmental and task constraints of the target sport(s).^{6,9} In example, transferable elements were found between futsal and football.¹⁰ However, cross-overs between sports are not limited to highly specialized athletes only. Diversification in youth development pathways can make an efficient cross-over by transfer of skill possible.^{3,8,11}

Success in sports can be perceived by different routes of development pathways (e.g. early specialization, early diversification) although, a linear assault of expertise is rare.¹² Many international athletes have participated in a variety of sports or movement activities before being successful in one specific sport.⁶ Participating in a variety of sports or movement activities has positive developmental traits for individuals; e.g. longer adherence to adult sports participation, longer athletic career, fewer drop out in sports, fewer injuries^{13,14} and it may increase the chance of a successful cross-over between sports^{3,6,8} compared to early specialization routes. Early diversification by practicing or participating in different sports and/or activities is suggested to be an option for learning a diverse set of skills that can be useful in several sports (e.g. Fundamental Movement Skills).¹⁵ The Athletic Skills Model (ASM)¹⁶ is an example of how early diversification can be conceptualized and facilitate transfer of skill. The ASM makes a clear distinction between (1) multisports (sampling sports with different task demands) and (2) donorsports (sports with similar task demands).

This study will focus on the analysis of task dynamics of different sports – in order to suggest multisports for an optimal early diversification program and donorsports for transfer of skill or possible cross-over – for one specific sport canoeing. Canoeing is a paddling sport according to the International Canoe Federation and is divided in the sub-disciplines kayak and canoe. In a canoe, the paddler kneels and uses a single-bladed paddle to propel the boat forward and in a kayak, the paddler is seated and uses a double-bladed paddle pulling the blade through the water on alternate sides to move forward. As a consequence, specific movement patterns vary to a certain extent between the two disciplines based on the constraints of the task (e.g. rules, boat type) while physical/physiological and anthropometric characteristics do to a lesser extent¹⁷. Furthermore, young paddlers have a distinct physical and anthropometric profile that maybe advantageous for prospective paddling athletes to possess.¹⁸

The identification of similarities and differences of task constraints in sports in comparison to canoe/kayak is expected to be a good option to (1) to search for donorsports by detecting similarities and (2) detect sports that differ to contribute to early diversification pathways (multisports). As shown by Robertson et al. (2018) analysis of important individuals' physical and

coordinative characteristics in tennis, table tennis, and badminton revealed clear between-sports similarities and differences based upon the experiential knowledge of the coach. In addition; experiential knowledge of the coach is a valid tool in assessing important characteristics per sport.²⁰ Without undervaluing the role of all previously mentioned important individual intrinsic abilities for a successful transfer, this study concentrates on the analysis of task constraints in sports (i.e. generic movement skills and physical/physiological abilities) and the importance of stature to the different sports. It is hypothesized that unique sport-profiles based upon the coaches' experiential knowledge, can be generated to identify (1) donorsports (similarities of task dynamics between sports) and (2) multisports (differences of task dynamics between sports, for an optimal early diversification pathway) for paddle sports.

2. Methods

The project has been conducted in accordance with recognized ethical standards and was approved by the ethics committee of the Ghent University Hospital (EC/2017/1548; Ghent, Belgium). A total of 891 coaches representing 19 different sports disciplines (i.e. archery; badminton; baseball; basketball; bowling; climbing; cycling; gymnastics; handball; judo; karate; netball; shooting; swimming; table tennis; tennis; soccer, volleyball and canoe/kayak) participated in the survey. The coaches were recruited through the national federation of the respective countries. The sport-specific characteristics for canoe/kayak were appointed by 67 coaches from 20 countries, Australia ($n=8$); Argentina ($n=1$); Belgium ($n=12$); Canada ($n=2$); Czech Republic ($n=1$); Denmark ($n=7$); Finland ($n=5$); Germany ($n=1$); Great Britain ($n=1$); Greece ($n=1$); Israel ($n=1$); Lithuania ($n=1$); New Zealand ($n=1$); Norway ($n=3$); Portugal ($n=2$); Singapore ($n=1$); Slovakia ($n=1$); Slovenia ($n=4$); Spain ($n=13$) and Switzerland ($n=1$). All of the coaches who participated in the survey had official coaching diplomas of their respective countries, and coached at recreational ($n=6$), regional ($n=13$); national ($n=19$) and international ($n=29$) level at time of the survey.

For the data collection process, an online survey (SurveyAnyplace) was used. The data were collected between October and December 2018. The starting page contained questions for gathering basic information (i.e. name, gender, age, and coaching qualifications). The survey on characteristics that are important in a specific sport, the 'I need' module was part of a long-term research project on talent identification initiated in 2007 in Flanders (Belgium); The Flemish Sports Compass (FSC).²¹ The I need questionnaire items which comprised 15 anthropometric, physical performance and motor skills characteristics (balance, core stability, pulling strength, speed, endurance, stature, flexibility, rhythm, agility, catching, throwing, climbing, kicking, jumping and hitting) enabled successful discrimination between sports. Participants were asked to indicate the level of importance for the aforementioned characteristics. Rating scales for all questions ranged from 0 to 10, with 0=not important at all and 10=very important. Preliminary analysis on a sample of 16 qualified coaches taken approximately 2 months apart revealed good test-retest reliability with Intra Class Correlation coefficients ranging from 0.804 to 0.989 (all p -values <0.001) for the individual items of the questionnaire.¹⁹

Statistical analysis was performed using Excel and SPSS-25. First, descriptive statistics are presented as means and standard deviations. Second, to search for contributing characteristics within the remainder sports for canoe/kayak it had to be determined which characteristics in canoe/kayak were most and least important. Characteristics rated above or equal to the average of the same characteristic in the remainder sports was appointed as impor-

tant, characteristics rated below average as less important for canoe/kayak. In order to identify potential donorsport and multisports, stature was excluded from the radar chart since it is not a task constraint. Third, a linear discriminant analysis (DA) was applied to elucidate the characteristics with discriminative power between canoe/kayak and the 18 remainder sports. Fourth, a MANOVA with post hoc analysis (Tukey) was used to evaluate (a) the similarities between canoe/kayak and 18 other sports for the important characteristics (b) the differences between canoe/kayak and 18 other sports for the less important characteristics. Two researchers independently analyzed the data between January and September 2019.

3. Results

Descriptive statistics for all sports and characteristics, can be found in Table 1. Additionally, the radar chart (Fig. 1a) shows the most important characteristics in canoe/kayak. A characteristic rated above or equal to the average of the same characteristic in the remainder sport was important; dynamic balance (8.51 ± 1.69), core stability (8.45 ± 2.27), pulling power (8.12 ± 1.68), speed (7.54 ± 2.07), endurance (7.27 ± 2.03), stature (6.43 ± 1.41) and rhythm (6.01 ± 3.01). According to the coaches' perspective, the least important characteristics for canoe/kayak were flexibility (6.16 ± 1.75), agility (4.27 ± 3.10), catching (3.90 ± 3.22), climbing (2.45 ± 3.05), jumping (1.81 ± 2.11), throwing (1.60 ± 2.24), hitting (0.94 ± 1.77) and kicking (0.61 ± 1.04).

The possibilities for donorsports and multisports toward canoe/kayak rely on the similarities and differences between sport-profiles. This resulted in a discriminant function ($\text{rcan}=0.660$, Wilks' $\text{Lambda}=0.564$, and $p < 0.001$). The cross validated DA showed that 72.1% of the canoe/kayak coaches were correctly assigned to their sport. The results show that it is possible to construct unique sport-profiles per sport, based on the experiential knowledge of the coach and at the same time, indicate to what extent sports differ and overlap to each other. The discrimination between canoe/kayak and the 18 other sports is visualized in Fig. 2.

In order to obtain the differences between sports' characteristics a MANOVA (Table 1) was conducted and showed significant results ($p < 0.05$) between canoe/kayak and other sports. Post hoc analyses revealed potential multisports from a particular sport toward canoe/kayak when a characteristic was valued significantly higher or equal for the important characteristics.

Post hoc analyses showed that archery, badminton, baseball, basketball, bowling, climbing, gymnastic, handball, judo, karate, netball, shooting, soccer, table tennis and tennis were valued equal or significant higher on *dynamic balance* compared to canoe/kayak. For *core stability* and *rhythm*, no significant difference between 18 sports and canoe/kayak. For *pulling power*, archery, basketball, bowling, climbing, gymnastic, handball and judo were all valued equal or significantly higher than canoe/kayak. While for *speed*, badminton, baseball, basketball, cycling, gymnastic, handball, judo, karate, netball, soccer, swimming, table tennis, tennis and volleyball were valued as significant more or equally important characteristic for their sport compared to canoe/kayak. With a view on *endurance* the analysis showed significantly higher or equal values for badminton, baseball, basketball, bowling, cycling, handball, judo, netball, shooting, soccer, table tennis and tennis than canoe/kayak.

In order to find complementary sports, post hoc analyses revealed the sports that can complement the characteristics of canoe/kayak that were rated relatively lower than average. When a sport was rated significantly higher compared to canoe/kayak for these characteristics, it was considered as a multisport.

Badminton, climbing, gymnastic, judo, karate, soccer, swimming, table tennis and tennis were rated significantly higher on

Table 1
Descriptives of the characteristics for all sports.

	Dynamic balance	Core stability	Pulling power	Speed	Endurance	Stature	Rhythm	Flexibility	Agility	Catching	Climbing	Jumping	Throwing	Hitting	Kicking
Archery (n=16)	7.69 ± 2.70 ^a	6.88 ± 3.26 ^a	7.63 ± 2.42 ^a	2.81 ± 3.06 ^a	3.38 ± 3.65 ^a	4.00 ± 3.77 ^a	3.88 ± 3.38 ^a	6.00 ± 3.06	2.69 ± 2.63	9.4 ± 1.73 ^a	7.25 ± 2.27 ^{a,b}	2.69 ± 3.36	1.31 ± 2.12	1.19 ± 2.59	1.00 ± 2.48
Badminton (n=86)	8.35 ± 1.57 ^a	8.19 ± 1.67 ^a	5.53 ± 2.71 ^a	9.17 ± 1.12 ^{a,a}	8.07 ± 1.77 ^a	6.28 ± 1.21 ^a	7.15 ± 2.52 ^a	7.80 ± 1.91 ^{a,b}	9.49 ± 86 ^{a,b}	4.35 ± 3.47	6.71 ± 3.23 ^{a,b}	8.91 ± 1.53 ^{a,b}	7.79 ± 2.41 ^{a,b}	8.80 ± 1.81 ^{a,b}	4.10 ± 3.62 ^{a,b}
Baseball (n=11)	6.55 ± 1.86 ^b	7.64 ± 1.91 ^a	4.45 ± 2.38 ^a	9.27 ± 0.91 ^a	5.55 ± 2.38 ^a	4.91 ± 1.14 ^a	5.09 ± 3.51 ^a	6.18 ± 1.17	8.91 ± 1.04 ^{a,b}	10.00 ± 0.00 ^{a,b}	18 ± 41	5.00 ± 2.15 ^{a,b}	10.00 ± 0.00 ^{a,b}	10.00 ± 0.00 ^{a,b}	45 ± 93
Basketball (n=36)	7.28 ± 2.07 ^a	7.75 ± 1.66 ^a	6.31 ± 2.51 ^a	8.78 ± 1.12 ^a	7.42 ± 1.73 ^a	7.86 ± 59 ^{a,a}	5.67 ± 2.76 ^a	6.53 ± 1.81	9.50 ± 7.0 ^{a,b}	9.75 ± 69 ^{a,b}	6.33 ± 3.55 ^{a,b}	9.11 ± 1.12 ^{a,b}	8.64 ± 1.73 ^{a,b}	4.11 ± 3.49 ^{a,b}	1.89 ± 2.48
Bowling (n=13)	9.31 ± 0.95 ^a	7.77 ± 1.69 ^a	5.54 ± 1.90 ^a	3.46 ± 3.55 ^a	5.08 ± 2.75 ^a	5.69 ± 95 ^a	7.54 ± 2.44 ^a	7.00 ± 2.35	5.15 ± 3.63	4.85 ± 4.85	2.54 ± 4.01	1.85 ± 2.34	5.69 ± 4.48 ^{a,b}	2.62 ± 4.13	.08 ± 28
Canoe/kayak (n=67)	8.51 ± 1.69	8.45 ± 2.27	8.12 ± 1.68	7.54 ± 2.07	7.27 ± 2.03	6.43 ± 1.41	6.01 ± 3.01	6.16 ± 1.75	4.27 ± 3.10	3.90 ± 3.22	2.45 ± 3.05	1.81 ± 2.11	1.60 ± 2.24	.94 ± 1.77	.61 ± 1.04
Climbing (n=19)	8.47 ± 2.17 ^a	9.05 ± 1.27 ^a	7.79 ± 1.99 ^a	3.47 ± 3.03 ^a	4.68 ± 2.93 ^a	4.47 ± 1.39 ^a	3.47 ± 3.03 ^a	8.47 ± 1.35 ^{a,b}	5.21 ± 2.55	2.74 ± 2.64	9.32 ± 1.20 ^{a,b}	4.32 ± 2.41 ^{a,b}	2.26 ± 2.73	1.05 ± 1.58	.63 ± 96
Cycling (n=103)	7.48 ± 2.13 ^a	7.80 ± 2.08 ^a	5.03 ± 3.08 ^a	8.14 ± 1.82 ^a	7.91 ± 2.51 ^a	6.14 ± 1.90 ^a	4.95 ± 3.19 ^a	7.09 ± 2.15	7.60 ± 2.19 ^{a,b}	6.55 ± 87 ^a	8.60 ± 1.23 ^{a,b}	7.08 ± 2.73 ^a	1.74 ± 2.26	1.66 ± 2.29	1.83 ± 2.48
Gymnastic (n=35)	9.29 ± 1.13 ^a	9.60 ± 7.0 ^a	7.17 ± 2.01 ^a	7.86 ± 1.73 ^a	4.63 ± 2.57 ^a	2.34 ± 1.11 ^a	7.91 ± 2.08 ^a	9.09 ± 1.34 ^{a,b}	7.26 ± 2.99 ^{a,b}	2.03 ± 2.61	7.09 ± 3.16 ^{a,b}	9.51 ± 7.8 ^{a,b}	1.94 ± 2.34	1.71 ± 1.28	1.49 ± 2.13
Handball (n=17)	8.18 ± 1.38 ^a	8.88 ± 1.17 ^a	6.65 ± 2.12 ^a	9.00 ± 1.06 ^a	7.06 ± 2.11 ^a	7.47 ± 72 ^a	6.18 ± 2.16 ^a	7.06 ± 1.56	9.47 ± 72 ^{a,b}	8.88 ± 94 ^{a,b}	8.53 ± 94 ^{a,b}	8.94 ± 90 ^{a,b}	9.71 ± 59 ^{a,b}	3.59 ± 3.04 ^{a,b}	2.00 ± 2.21
Judo (n=26)	8.73 ± 1.49 ^a	8.96 ± 1.08 ^a	8.69 ± 1.44 ^a	8.54 ± 1.70 ^a	6.19 ± 2.91 ^a	5.00 ± 75 ^a	5.50 ± 3.41 ^a	7.77 ± 1.70 ^{a,b}	9.23 ± 1.03 ^{a,b}	1.65 ± 93 ^a	7.04 ± 3.44 ^{a,b}	6.35 ± 3.27 ^{a,b}	1.00 ± 1.83	23 ± 51	.50 ± 95
Karate (n=21)	9.24 ± 1.00 ^a	8.81 ± 1.72 ^a	4.57 ± 3.33 ^a	9.14 ± 96 ^a	5.00 ± 3.42 ^a	5.05 ± 87 ^a	7.95 ± 2.08 ^a	8.76 ± 1.18 ^{a,b}	9.29 ± 1.10 ^{a,b}	1.29 ± 3.10 ^a	7.95 ± 2.85 ^{a,b}	8.05 ± 1.72 ^{a,b}	1.33 ± 2.35	2.00 ± 3.27	1.71 ± 2.99
Netball (n=28)	9.00 ± 1.44 ^a	8.86 ± 1.48 ^a	5.86 ± 2.38 ^a	8.64 ± 1.55 ^a	8.32 ± 1.96 ^a	7.61 ± 1.73 ^a	6.86 ± 2.03 ^a	7.32 ± 1.85	9.18 ± 1.22 ^{a,b}	9.26 ± 1.42 ^{a,b}	.89 ± 1.10	9.11 ± 1.34 ^{a,b}	9.43 ± 1.10 ^{a,b}	1.71 ± 2.19	.89 ± 1.13
Shooting (n=30)	9.23 ± 1.72 ^a	8.53 ± 2.75 ^a	2.40 ± 2.93 ^a	1.00 ± 2.44 ^a	5.70 ± 3.05 ^a	5.00 ± 00 ^a	5.33 ± 3.01 ^a	6.10 ± 3.51	1.07 ± 2.08 ^a	6.60 ± 4.36 ^{a,b}	1.73 ± 3.08	1.33 ± 51 ^a	.13 ± 51	.13 ± 51	.13 ± 51
Soccer (n=92)	7.65 ± 1.47 ^a	7.76 ± 1.54 ^a	5.88 ± 2.50 ^a	8.89 ± 1.13 ^{a,a}	7.55 ± 1.67 ^a	5.39 ± 85 ^a	6.41 ± 2.50 ^a	7.32 ± 1.83 ^a	9.09 ± 1.07 ^{a,b}	7.89 ± 83 ^{a,b}	7.47 ± 2.32 ^{a,b}	7.88 ± 1.56 ^{a,b}	6.13 ± 2.45 ^{a,b}	3.53 ± 3.09 ^{a,b}	9.25 ± 1.12 ^{a,b}
Swimming (n=61)	6.98 ± 2.35 ^a	7.69 ± 2.53 ^a	6.05 ± 3.00 ^a	8.15 ± 1.71 ^a	3.61 ± 3.35 ^a	7.44 ± 87 ^{a,a}	5.75 ± 3.32 ^a	7.75 ± 1.96 ^{a,b}	7.15 ± 2.54 ^{a,b}	.97 ± 1.94 ^a	6.79 ± 2.72 ^{a,b}	5.92 ± 3.24 ^{a,b}	1.62 ± 2.53	1.08 ± 2.00	1.05 ± 2.08
Table Tennis (n=89)	8.18 ± 1.44 ^a	8.47 ± 1.42 ^a	4.88 ± 2.14 ^a	8.97 ± 1.22 ^{a,a}	7.64 ± 1.56 ^a	5.70 ± 2.11 ^a	6.89 ± 2.20 ^a	7.30 ± 1.87 ^{a,b}	8.70 ± 1.34 ^{a,b}	5.02 ± 3.06	7.18 ± 2.06 ^{a,b}	7.75 ± 1.90 ^{a,b}	6.69 ± 2.47 ^{a,b}	9.16 ± 1.75 ^{a,b}	5.69 ± 2.69 ^{a,b}
Tennis (n=92)	8.32 ± 1.54 ^a	7.96 ± 1.74 ^a	5.61 ± 2.43 ^a	8.89 ± 1.12 ^{a,a}	7.13 ± 2.18 ^a	7.38 ± 1.78 ^a	7.39 ± 2.73 ^a	7.35 ± 1.78 ^a	8.96 ± 1.22 ^{a,b}	5.08 ± 3.08	7.61 ± 1.66 ^{a,b}	7.48 ± 1.95 ^{a,b}	8.08 ± 2.09 ^{a,b}	9.23 ± 1.31 ^{a,b}	5.85 ± 3.54 ^{a,b}
Volleyball (n=49)	7.04 ± 2.06 ^a	8.76 ± 1.36 ^a	5.22 ± 2.38 ^a	8.27 ± 1.50 ^a	4.65 ± 2.39 ^a	8.71 ± 58 ^{a,a}	4.63 ± 2.86 ^a	6.67 ± 2.00	8.98 ± 88 ^{a,b}	5.59 ± 3.62	6.84 ± 2.93 ^{a,b}	9.57 ± 68 ^{a,b}	7.55 ± 2.96 ^{a,b}	9.59 ± 1.27 ^{a,b}	2.39 ± 2.40 ^{a,b}

^a Significant difference with canoe and kayak ($p < 0.05$).

^{**} Significant difference with canoe and kayak ($p < 0.01$).

^a Potential donorsport.

^b Potential multisport.

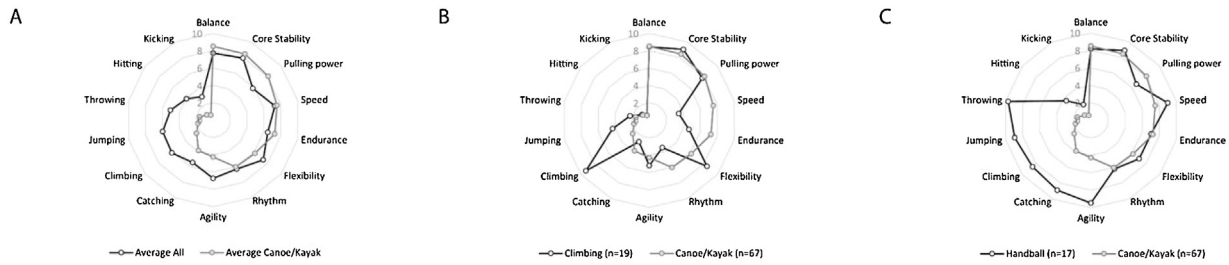


Fig. 1. Sport-profiles based on 14 characteristics indicating: Average value of all sports vs. average value canoe/kayak (a), an example of a donorsports; climbing toward canoe/kayak (b) and an example of a multisport; handball toward canoe/kayak (c).

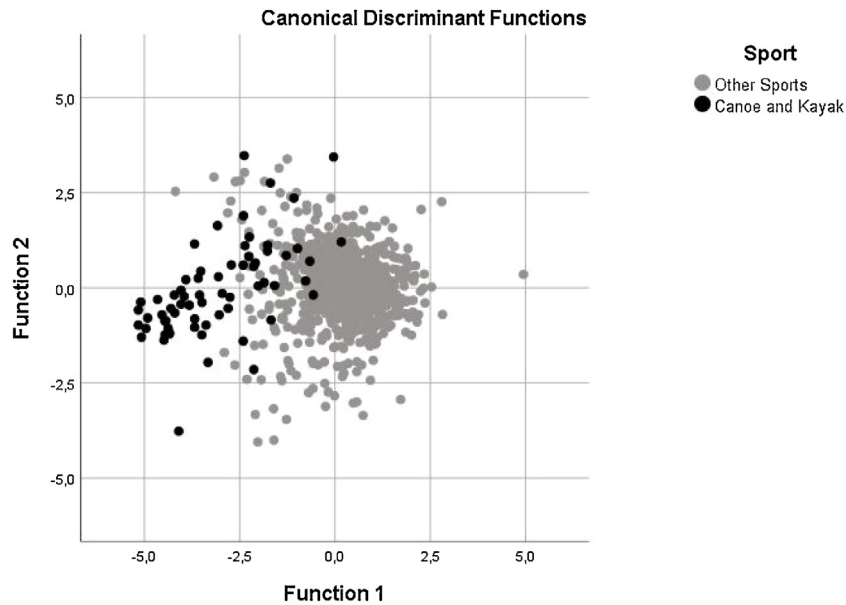


Fig. 2. The scatter plot has the canonical discriminant function coefficients at its axes, with Function 1 on x-axis and Function 2 on the y-axis. The two-group cluster within the two-dimensional space indicating that the functions discriminate between canoe/kayak and 18 other sports.

flexibility compared to the perspective of canoe/kayak coaches. The analysis of *agility* showed significantly higher values for badminton, baseball, basketball, cycling, gymnastic, handball, judo, karate, netball, soccer, swimming, table tennis, tennis and volleyball. Coaches of baseball, basketball, handball, netball, shooting and soccer rated *catching* significantly higher than canoe/kayak coaches. For *climbing*, archery, badminton, basketball, climbing, cycling, gymnastic, handball, judo, karate, soccer, swimming, table tennis, tennis and volleyball were rated significantly higher than canoe/kayak. Badminton, baseball, basketball, climbing, cycling, gymnastic, handball, judo, karate, netball, soccer, swimming, table tennis, tennis and volleyball coaches valued *jumping* significantly higher compared to the perspective of canoe/kayak coaches. Badminton, baseball, basketball, bowling, handball, netball, soccer, table tennis, tennis and volleyball were rated significantly higher in *throwing* compared to canoe/kayak. From the viewpoint of badminton, baseball, basketball, handball, soccer, table tennis, tennis and volleyball coaches, *hitting* was valued significantly higher than canoe/kayak coaches' perspective. *Kicking* was rated significantly higher for badminton, soccer, table tennis, tennis and volleyball than canoe/kayak.

4. Discussion

The aim of this study was to analyze differences and similarities between nineteen different sports in order to search for donorsports and multisports toward canoe/kayak. Based upon the

experiential knowledge of the coach, the systematic analysis of the relative importance of different characteristics per sport revealed that (1) all included sports could be uniquely identified by their profiles and (2) specifically for canoe/kayak seven items were found important (i.e. dynamic balance, core stability, pulling power, speed, endurance, stature and rhythm), and eight items were found less-important (i.e. flexibility, agility, catching, climbing, jumping, throwing, hitting and kicking) compared to the average of the characteristics of the remainder sports. The results indicate that based upon the relative importance of task constraints for each sport included, for canoe/kayak multisports and donorsports could be identified per characteristic. Under this account, potential donorsports could be, gymnastics and netball, and potential multisports could be handball, badminton, basketball and tennis.

The coach ratings are a result from experiential knowledge of task (e.g. rules, different disciplines, boat type) and athlete constraints, of the coaches. The paddling athletes' stature and body dimensions are important for the propulsion of the craft – large upper body girth, large flexed arm girth, narrow hips, and lean body mass – are shown to be important for paddling performance.²² Propelling a vessel through an instable surface demands adaption toward a constantly changing environment, therefore paddling sports require well developed balancing performance.²³ The propulsion of the craft (e.g. pulling/pushing and trunk rotations) can mostly be explained by upper body muscle actions.²⁴ Therefore, paddlers require significant upper body strength, core strength and stabilization.²⁵ Moreover, maintaining

a constant propulsion with a high rhythm of upper body limb movement, requires high amounts of aerobic and anaerobic attributes.²⁶

This study systematically analyzed task constraints of different sports by constructing unique sport-profiles (Fig. 1a–c) and searched for donorsports and multisports for specific targetsports. More specifically, sports for which performance is mainly built upon task constraints that are similar to canoe/kayak can fulfill the role of donorsport. Dynamic balance, pulling power and core stability are valued high both in climbing as in paddling sports (e.g. matching characteristics; Fig. 1b), therefore climbing can be seen as potential donorsport for canoe/kayak. However, climbing as a task was valued relatively low by the Canoe/kayak coaches. A possible explanation could be that climbing as a skill was addressed only as vertical motion, rather than climbing on changing overhangs and with sideway movements. Furthermore, searching for similarities between sports can facilitate the identification of potential talents and enlargement of talent pools for athletes who are open to a cross-over to a new sport. Moreover, development pathways from junior to senior in one sport are observed although the non-linear pathway where athletes switch between sports is more common.¹² Recycling talent by NGB's is well known (e.g. Girls 4 Gold and Sporting Giants; UK Sport).^{2,4} These initiatives mainly focus on the identification of athletes' capabilities and try to match these with task demands of different target sports. More specifically the Australian Institute of Sport (AIS) searched and identified possible talents to transfer to skeleton in order to succeed in the 2006 Olympic Winter Games of Torino.³ This study adds that a systematic analysis of the demands of sports can make an identification process for potential cross-overs possibly more effective. Formal initiatives could search more specifically in related sports (e.g. matching profiles see Fig. 1b) in order to attract talents into their talent pool.

It is suggested that formal talent transfer initiatives lack efficacy and that it may make more sense to invest in well-integrated talent development systems.⁴ It is well established in the literature that early diversification in sports contributes to a healthy development (i.e. learning emotional, cognitive and motor skills) of young athletes, that it won't interfere with a possible desired future in elite sports^{13,15,27} and makes fast-tracking of cross-over athletes in a new sport possible.³ As defined; sport is an activity that requires the integration of human abilities and processes²⁸ (e.g. kicking, jumping, endurance). However not all sports demand similar abilities and processes^{29,30} as the unique sport-profiles also show in this study. In order to construct all-round development programs for young athletes, identifying the differences in representation of task characteristics in sport-profiles might help identifying sports that are complementary. Therefore, characteristics that are under-represented in one sport can be complemented by identifying sports that have an over-representation of that similar element.

This novel approach to search for similarities and differences between sports is promising although it has its limitations. The method does not rank sports with the greatest overlap or differences toward canoe/kayak and therefore it is not possible to suggest one particular sport as donor- or multisport. Furthermore, the method of obtaining similarities and differences between sports is based on calculating grand mean of the included nineteen sports and their corresponding characteristics. Conclusions regarding the importance of characteristics per sport may change if more or different sports are included. Although, the dataset did not contain all sports recognized by the IOC, it represents a diverse and large number of sports; different skill-level (e.g. gymnastics vs. cycling) and variety (3 target, 3 invasion/territory, 5 net/wall, 1 strike/fielding, 7 individual pursuit sports). The questionnaire was based on the FSC dataset and contained task and individual characteristics only (e.g. psychological, environmental and social items were not included).

It is acknowledged that searching for similarities and differences between sports should be approached multidimensional^{4,5} in order to optimally search for potential donorsports and multisports. Moreover, it can be questioned whether the perception of the coach of the traits of a sport correlates with the actual development of the corresponding performance characteristics of an athlete over time. Although the experiential knowledge of the coach is a valid tool in obtaining important task constraints per sport.²⁰ Future research could focus on the relation between the obtained sport-profiles based up on the coaches' view (task dynamics) and the development of physical and motor characteristics of the athlete (individual dynamics) per developmental phase.

5. Conclusion

In general, constructing and analyzing sport-profiles enable professionals to identify differences and similarities between sports. Similarities between sports can make the identification of sports for potential cross-overs as a product of giftedness, personal attributes and invested effort possible. Differences between sports can facilitate the construction of an all-round development framework (multisport program) during the sampling phase of young athletes.

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