The differences in motor and cognitive abilities between the more and less successful 12–14 years old judokas

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Source of support: Departmental sources

Received: 22 April 2010; **Accepted:** 28 April 2010; **Published online:** 12 May 2010

Abstract

Background and Study Aim: This study attempted to single out factors related to success in judo in judokas aged 12–14 years. The authors of this work thought it was necessary to define both basic motor and cognitive profiles of judokas for the purpose of better recruitment for the sport as well as evaluation of the training process itself.

Material/Methods: Participants were assigned to either „Medallist" or "Non-medallist", according to their previous results in competitions at the national level. Medallist consisted of 83 children (54 boys, 13.07±0.21 yrs; and 29 girls, 13.08±1.48 yrs) who have, in the last two years, won one or more individual medals at the national championships. Non-medallist had 82 children (55 boys, 12.89±1.42 yrs; and 27 girls, 12.78±1.23 yrs) who still have not won a medal at the national championships. The battery of eight motor tests and The Raven's Standard Progressive Matrices used in this research.

Results: The results of cognitive and motor abilities show that Medallist generally performed better in all tests than Non-medallist both for male and female judokas. The largest contribution to the differences specifically came from the Obstacle course backwards, Crossed-arm sit-ups, Standing broad jump and Bent-arm hang tests, as well as from cognitive abilities (assessed by the Raven's Standard Progressive Matrices).

Conclusions: It can be concluded that the more successful judokas generally possess better cognitive abilities, coordination and strength than less successful ones.

Key words: The Raven's Standard Progressive Matrices • motor profile • cognitive profile

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Background

Considering the lack of research on anthropometric characteristics of success in judo in children aged 12–14 years, this study attempted to single out factors related to success in judokas of this age. As there were no significant differences between more and less successful young judokas in anthropometric characteristics, the authors did not analyse the morphological space [1]. The authors of this work thought it was necessary to define both basic **motor and cognitive profiles** of judokas for the purpose of better recruitment for the sport as well as evaluation of the training process itself. In recruiting athletes for judo, it is important to focus on particularly those characteristics and abilities which have the greatest influence on sports performance or result, including the ones mostly determined by genetic factors. In the process of evaluation of the training process, parameters of the individual training status are used to monitor variables affected and targeted by training (eg., abilities sensitive to environmental factors, specific physical activities such as programmed training), and also of great importance for athletic performance.

The purpose of this investigation was to isolate the cognitive and motor characteristics which differentiate the

Motor profile – contents the abilities which are specifically related to the performance of a motor skill.

Cognitive profile – contents the abilities which are the brain-based skills and mental processes that are needed to carry out any task.

more from less successful competitors. Considering that a judo match is an interval activity consisting of maximal (explosive) effort interrupted by short breaks [2,3], the authors assumed that strength and power are relevant determinants of success. On the other hand, the complexity of the combat structure, as well as a large number of techniques used in a fight, may suggest that cognitive abilities and coordination also represent key determinants for success in judo, which has been suggested before [4–8]. Such a defined structure of cognitive and motor abilities in judo can be viewed as valuable from both the scientific and practical point of view.

This paper was created as a part of science-research project "Anthropological status and physical activity of Vojvodina population", co-financed by the Provincial Secretariat for Science and Technological Development of Vojvodina, which is accomplished by the Faculty of Sport and Physical Education in Novi Sad.

Material and Methods

Subjects

The subject pool was made up of 165 judokas (109 boys and 56 girls). Participants were assigned to either „Medallist" or "Non-medallist", according to their previous results in competitions at the national level. Medallist consisted of 83 children (54 boys, 13.07±0.21 yrs; and 29 girls, 13.08±1.48 yrs) who have, in the last two years, won one or more individual medals at the national championships. Non-medallist had 82 children (55 boys, 12.89±1.42 yrs; and 27 girls, 12.78±1.23 yrs) who still have not won a medal at the national championships. Training experience for both groups ranged from 2–10 years. Judo practices were mostly 90 min. per day, five times per week. The sample was drawn from a number of judo clubs in the Serbian Province of Vojvodina.

Both the children and their parents were fully informed about the nature and purpose of the study and the research was undertaken in compliance with the Helsinki Declaration. There was no relevant health problems reported.

Measurements and tests

The battery of eight motor tests used in this research estimates the effectiveness of the following functional mechanisms: movement structuring, tonus and synergetic regulation, regulation of excitation intensity and regulation of excitation duration [9,10]. Motor abilities of boys and girls were estimated by these motor test battery:

- functional coordination: 1) *Obstacle course backwards*, 2) *Slalom with 3 balls*;
- frequency of simple movements: 3) *Arm plate tapping*;
- flexibility: 4) *Forward bend from straddle sitting position*;
- power (explosive strength): 5) *Standing broad jump*;
- muscular endurance (isometric strength): 6) *Bent-arm hang*;
- muscular endurance (isotonic strength): 7) *Crossed-arm sit-ups.*
- speed of running: 8) *20-m dash.*

A short description of the motor tests follows. Every child was given an opportunity to rehearse the test before registering the results. This way more adequate and reliable results were obtained.

1. *Obstacle course backwards.* The child has to walk backwards on all fours and cover the distance of 10 m, climb the top of Swedish bench and go through the frame of the bench. The task is measured in tenths of a second.
2. *Slalom with 3 balls.* On command "GO" the child rolls three balls between cones and cover the distance of 10 m. After he/she passes the last of five cones, the child turns around it continuing rolling the balls around the cones toward the start line. The task is completed when the child rolls all three balls over the start line. The score is the length of time required to complete the task, measured in tenths of second.
3. *Arm plate tapping.* For fifteen seconds the child has to tap alternately two plates on the tapping board with his dominant hand, while holding the other hand in between the two plates. The result is the number of alternate double hits.
4. *Forward bend from straddle sitting position.* The child sits on a floor, leaning against the wall, in straddle position and bows forward as deep as possible. A straight-angle ruler lies down in front of the child and he/she reaches the scale with cm as far as he/she can. The result is the depth of the reach measured in cm.
5. *Standing broad jump.* The child jumps with both feet from the reversed side of Reuter bounce board onto a carpet, which is marked in cm. The result is the length of the jump in cm.
6. *Crossed-arm sit-ups.* The child lies on his/her back with his/her knees bent and arms crossed on the opposite shoulders. He/she rises into a seated position and returns into the starting position. The instructor's assistant holds the child's feet. The result is the number of correctly executed rises to the seated position (no longer than 60 seconds).
7. *Bent arm hang.* The child under-grips the bar and holds the pull-up as long as he/she can (chin above the bar). The result is the time of the hold measured in tenths of a second.
8. *20 m dash.* On command "GO" the child that stands behind the start line has to run 20 m as fast as he/she can to the end of track (20 m). The children run in

Table 1. Descriptive statistics of boys.

Variable	Medallist		Non-medallist mmmemedalist		F	p
	M	SD	M	SD		
20 m dash (0.1 s)	38.3	2.9	40.7	3.8	13.12	.00
Obstacle course backwards (0.1 s)	105.2	20.6	138.6	39.4	30.45	.00
Slalom with 3 balls (0.1 s)	347.5	67.3	373.1	96.0	2.59	.11
Arm plate tapping (freq)	30.4	5.0	27.7	4.4	8.69	.00
Forward bend from straddle sitting position (cm)	51.0	10.7	44.5	10.0	10.86	.00
Standing broad jump (cm)	199.3	23.3	179.6	25.1	17.88	.00
Bent arm hang (0.1 s)	534.6	261.4	347.6	226.5	15.93	.00
Crossed-arm sit-ups (freq)	50.1	8.0	42.6	9.6	19.24	.00
Raven's standard progressive matrix (points)	43.0	10.1	36.8	12.7	7.67	.01

pairs. The score was the time of running, measured in tenths of second.

Consequently, these tests were the manifestation of the hypothetical functional mechanism of young people, which means that they could be virtually taken as primary latent motor dimensions. This approach was chosen to decrease the sample of motor tests, due to the significant organizing and motivational problems which exist in testing procedures with pre-school children.

Cognitive abilities (for abstract reasoning) were assessed by the **Raven's Standard Progressive Matrices** (RSPM). RSPM are multiple choice tests and in each test item a candidate is asked to identify the missing segment required to complete a larger pattern. Many items are presented in the form of a 3×3 or 2×2 matrix, giving the test its name. There are five sets (A to E) of 12 items each (e.g. A 1 through to A 12), with items within a set becoming increasingly difficult, requiring ever greater cognitive capacity to encode and analyze information.

Data analysis

Multivariate and univariate differences between two groups of subjects in the sample of variables were calculated and tested by the programs MANOVA and ANOVA. Means (M) and standard deviations (SD) of every variable in each group reported with the tests of significance of differences between groups ($p<0.05$ was considered as statistically significant). The structure of differences in entire sample of variables, and the importance of each variable at the discrimination between the groups, was analysed by discriminant analysis. All statistical analyses were calculated by the SPSS (15.0) statistical package.

Results

Table 1 shows descriptive statistical parameters of motor variables and the variable of intelligence in boys, as well as the analysis of variance (ANOVA). Based on the F-test and its significance, it can be concluded that there were significant differences in all motor variables except Slalom with 3 balls. Medallist recorded better results compared to Non-medallist. Additionally, Medallist were better by 6.2 points vs. Non-medallist on the intelligence test ($p=0.01$).

Regarding discriminative canonical analysis, canonical correlation of.57 and Willk's Lambda of 0.66 revealed statistical significance at $p=.00$ in Medallist vs. Non-medallist. It can be observed from Table 2 that Obstacle course backwards, Crossed-arm sit-ups, Standing broad jump, and Bent-arm hang, contributed the most to between-group differences.

The same statistical procedures were applied for the girls. The differences in motor abilities between the more successful and less successful female judokas were not as pronounced as in males. Significant differences were found in the following motor assessments: Obstacle course backwards, Standing broad jump, Bent-arm hang, Crossed-arm sit-ups and Raven's standard progressive matrix (Table 3). These findings support the notion that the differences in cognitive and motor abilities in the two groups of female judokas are exposed primarily on the tests requiring coordination and strength (explosive, static and repetitive).

According to the structure of the isolated discriminant function (Table 4), the most significant contributors to between-group differences in the girls are the tests of

The Raven's Standard Progressive Matrices – measures a person's ability to form perceptual relations (Spearman's g) and to reason by analogy independent of language and formal schooling, and may be used with persons ranging in age from 6 years to adult.

Table 2. Summary of canonical discriminant function.

Variable	Standardized canonical discriminant function coefficients	Structure
20 m dash	.69	–.49
Obstacle course backwards	–.74	–.75
Slalom with 3 balls	.16	–.22
Arm plate tapping	.14	.40
Forward bend from straddle sitting position	.33	.45
Standing broad jump	.20	.57
Bent arm hang	.45	.54
Crossed-arm sit-ups	.27	.60
Raven's standard progressive matrix	.20	.37
Canonical correlation	.57	
Wilks' Lambda	.66	
Chi-square	41.46	
P	.00	
Group centroids	Group	
	Medallist	.71
	Non-medallist	–.69

Table 3. Descriptive statistics of girls.

Variable	Medallist		Non-medallist medalist		F	p
	M	SD	M	SD		
20 m dash (0.1 s)	40.6	3.7	42.0	2.7	2.39	.12
Obstacle course backwards (0.1 s)	115.5	21.7	139.1	19.8	17.90	.00
Slalom with 3 balls (0.1 s)	351.9	52.7	377.7	56.1	3.12	.08
Arm plate tapping (freq)	32.0	4.2	30.3	3.5	2.72	.10
Forward bend from straddle sitting position (cm)	55.3	12.7	49.9	9.1	3.29	.07
Standing broad jump (cm)	186.1	15.9	167.4	16.3	18.84	.00
Bent arm hang (0.1 s)	382.5	207.2	280.0	182.6	3.83	.05
Crossed-arm sit-ups (freq)	50.1	7.4	42.0	5.9	15.93	.00
Raven's standard progressive matrix (points)	46.3	6.0	40.5	7.0	11.03	.00

explosive strength (Standing broad jump), coordination (Obstacle course backwards), repetitive strength (Crossed-arm sit-ups, and cognitive ability (Raven's standard progressive matrices).

Discussion

The results of cognitive and motor abilities show that Medallist generally performed better in all tests than Non-medallist both for male and female judokas. The largest contribution to the differences specifically came from the Obstacle course backwards, Crossed-arm sit-ups, Standing broad jump and Bent-arm hang tests. It is interesting to note that differences in one coordination test (Obstacle course backwards) were not found in the other (Slalom with 3 balls). This finding may suggest that, apart from the whole-body coordination that both of these tests truly assess, Obstacle

Table 4. Summary of canonical discriminant function.

Variable	Standardized canonical discriminant function coefficients	Structure
20 m dash	.17	–.24
Obstacle course backwards	–.52	–.67
Slalom with 3 balls	–.22	–.28
Arm plate tapping	–.27	.26
Forward bend from straddle sitting position	–.01	.29
Standing broad jump	.48	.69
Bent arm hang	–.30	.31
Crossed-arm sit-ups	.48	.63
Raven's standard progressive matrix	.29	.53
Canonical correlation	.65	
Wilks' Lambda	.58	
Chi-square	27.17	
P	.00	
Group centroids	Group	
	Medallist	.81
	Non–medallist	–.87

course backwards also assesses the ability of "reorganization" of a movement stereotype, leading us to conclude that the more successful judokas better adapted to the "new conditions". During a judo match, it is expected that a judoka, besides well-acquired technical-tactical stereotypes, possesses the ability for an immediate reorganization and subsequent creation of totally new programmes of functioning. A judo match demands a swift change of movement in order to avoid attack, as well as to attack and score points. Long-term training of certain kinesiological activities, combined with frequent occurrences of stress associated with problem-solving during competition, contribute to building relatively specific cognitive functioning, requiring a strong interaction between the parallel, serial and perceptive processors [11]. According to this and other findings (5,), as well as previous practice, experience and tradition, it has been postulated that, the more complex a sport structure is, the more relevant an athlete's cognitive abilities are for sport success. Our study has demonstrated that cognitive abilities may be more of a factor in girls than boys, with Medallist performing better than Non-medallist, regardless of gender. Moreover, it is obvious that Medallist, both in boys and girls, demonstrated substantially greater abdominal endurance compared to Non-medallist. Previous research [12–15] agree that upper-body strength and endurance play a very important role in sport success, and also in injury prevention. Explosive strength of legs in judo can be expected, considering that explosive movements dominate in a judo match. As in other sports, quick, explosive movements in all directions are of key importance, along with maintaining balance, speed and accuracy of motion. It is necessary to timely react in rapid change of direction, both in attack and defence, with the maximal strength and quickness. The duration and nature of a judo fight also sets specific demands on motor and functional abilities of a judoka [16,17], hence the better performance of the more successful judokas in the present study.

Conclusions

In conclusion, one can say that differences in cognitive and motor abilities between the more vs. less successful judokas of either gender have been found primarily in all forms of strength and coordination, but also in other motor abilities. It can be concluded that the more successful judokas generally possess better cognitive ability, coordination and strength than less successful ones.

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