

Canonic discriminative analysis in Mahalanobis' space as a method for determining differences between conative dimensions of athletes who practice judo and karate

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Abstract

Canonic discriminative analysis can be defined as a solution of quazi canonic problem $\mathbf{M}\mathbf{x}_k = \mathbf{k}_k$, $\mathbf{G}\mathbf{y}_k = \mathbf{l}_k$ | $\mathbf{c}_k = \mathbf{k}_k^t \mathbf{l}_k = \text{maximum}$, $\mathbf{x}_k^t \mathbf{x}_k = \mathbf{y}_k^t \mathbf{y}_k = \delta_{kk}$ $k = 1, \dots, s$; $s = \min((g - 1), m) = m$ where δ_{kk} is Kroneker's symbol, and \mathbf{x}_k and \mathbf{y}_k are unknown m-dimensional vectors. As $\mathbf{c}_k = \mathbf{x}_k^t \mathbf{A}\mathbf{y}_k$, the function which is to be maximized is, for $k = 1$, $f(\mathbf{x}_k, \mathbf{y}_k, \lambda_k, \eta_k) = \mathbf{x}_k^t \mathbf{A}\mathbf{y}_k - 2^{-1}\lambda_k(\mathbf{x}_k^t \mathbf{x}_k - 1) - 2^{-1}\eta_k(\mathbf{y}_k^t \mathbf{y}_k - 1)$. Differentiating this function by the elements of vector \mathbf{x}_k $\partial f / \partial \mathbf{x}_k = \mathbf{A}\mathbf{y}_k - \lambda_k \mathbf{x}_k$, and differentiating by the elements of vector \mathbf{y}_k $\partial f / \partial \mathbf{y}_k = \mathbf{A}\mathbf{x}_k - \eta_k \mathbf{y}_k$; after equaling it with zero

$$\mathbf{A}\mathbf{y}_k = \lambda_k \mathbf{x}_k \text{ and } \mathbf{A}\mathbf{x}_k = \eta_k \mathbf{y}_k.$$

Differentiating by λ_k and η_k , and from the condition $\mathbf{x}_k^t \mathbf{x}_k = 1$ and $\mathbf{y}_k^t \mathbf{y}_k = 1$, it is easily obtained that $\lambda_k = \eta_k$. As $\mathbf{A}^t = \mathbf{A}$, by multiplication of the first result with \mathbf{x}_k^t , and the second result with \mathbf{y}_k^t

$$\mathbf{x}_k^t \mathbf{A} \mathbf{y}_k = \lambda_k \text{ and } \mathbf{y}_k^t \mathbf{A} \mathbf{x}_k = \lambda_k$$

with $\mathbf{x}_k = \mathbf{y}_k$, the problem is reduced to a simple problem of eigenvalues and matrix \mathbf{A} vectors, that is to the solution of the problem $(\mathbf{A} - \lambda_k \mathbf{I}) \mathbf{x}_k = \mathbf{0}$, $k = 1, \dots, m$ so $c_k = \rho_k^2 = \mathbf{x}_k^t \mathbf{A} \mathbf{x}_k = \lambda_k$, $k = 1, \dots, m$ are squares of canonic correlations between linear combinations of variables from \mathbf{M} and \mathbf{G} which are proportional to the differentiation of centroids of subsamples defined by the selective matrix \mathbf{S} in the space between vectors of the variables from \mathbf{M} .

Key words: canonic/discriminant/quasi/function/correlation/eigenvalues/

1. Introduction

The reason for the increased number of researches of the athletes' personalities should be searched for in the characteristics of sports, which imposes exclusive and different requests not only in respect to motor abilities, but personality as well. This justifies the assumption that active and successful participation in certain sports, including martial arts (judo and karate), demands for specific personality dimensions which are the most appropriate for those sports, or personality dimensions suitable for sports, and not some other activities too.

Observing the technique of judo in general, it is noticed that it is made of numerous simple and complex movements. All of them demand certain speed, coordination, pliability, precision and strength of the performer. Considering that they are performed in a close contact (guard) with the opponent, it largely makes them harder to be performed correctly and accurately. That is why it can be stated that judo technique is the most abundant one compared to all other sports. In this sport, it is possible to perform more than 1,500 different movements. For this reason, it is characterized by a great number of technical elements and even greater number of different versions they can be performed in, and also by innumerable structures of movement which are performed in order to conduct tactical idea. The great richness of movements in judo is also shown by the need to perform greater part of technique making movements which are coordinated and combined with other movements and actions. All of them are aimed towards different directions of the frontal, sagittal and horizontal plane. The fact that it is often necessary to make, at least a little change in the adopted dynamic stereotype when the opponent changes, makes the technique of this sport even more varied. During a judo match, changeable conditions which can be defined as a typical build of the opponents body, typical guard, fighting style (of-

fensive or defensive), the way of moving in new situations, repertoire of techniques occur and demand creativity from a judoist so that he can instantly modify dynamic stereotype and react properly according to the opponent's activity. Judo, as a sport discipline, is limited by the rules and consequently the techniques (movements) have to be practised to perfection since only then they can be valued (Popović D. 2004.) During the practice and matches, within the unit of time, mobilization of the large quantity of energy is required. Proper and quantitatively sufficient nutrition ensures optimal quantity of energy necessary for the judoist at any time.

Judo technique can be divided into seven groups:

1. Posture technique (Shizen hon tai)
2. Movement technique (Tai sabaki)
3. Falling technique (Ukemi waza)
4. Throwing technique (Nage waza)
5. Joint locks technique (Kansetsu waza)
6. Choking technique (Shime waza)
7. Pinning technique (Osaekomi waza)
8. Kata technique (Kata waza)

While this sport was developing, a group of striking techniques (Atemi waza) was discarded. Performing Kappo technique (first aid technique) and Kuatsu (healing technique) are separate.

Karate has been rooted worldwide for a long time now. It consists of complex motor activities with one single goal – efficiency. Unlike judo, karate allows strokes with the compulsory use of protective equipment from injury. It is characterized by movements in sagittal, frontal and horizontal plane. To perform karate techniques properly, speed, strength and pliability are necessary along with maximum concentration of both physical and mental energy.

Karate technique implies external elements of karate in a narrow sense. It is a set of mostly physical karate components, although the division on physical and other components is not possible. Karate is integral martial art and each attempt do divide it as well as the strive to be sustained, would immediately lead to an impoverishment, and that is the point where the significance is lost. It is necessary to make a distinction between Karate wasa and Gokataken. Gokataken is a complete set of techniques, methods, praxis, experiences, kata, tradition, legends, basic ideas and the spirit of a school and it comprises esoteric parts of karate such as massage and self-massage (Katsu), healing with herbs, some kinds of acupuncture and methods of special impact (Gigov, V. 1988). It could be said that Karate wasa is only integral part of Gokataken wasa without which the latter one would be incomplete.

Karate techniques are divided into following groups:

1. Posture technique (Shizen hon tai)
2. Movement technique (Tai sabaki)
3. Hand technique (Te waza)
4. Leg technique
5. Blocking techniques
6. Joint locks technique (Kansetsu waza)
7. Self-defense elements (Jiu-jutsu)
8. Kata technique (Kata waza)

When we speak about Kata techniques, we refer to the series of karate techniques, most often performed in the form of stylized fights against imaginary opponents during which the postures, blocks and strokes are arranged in a certain manner and in a certain order, and due to those established forms, only the authentic karate skills are successful way of learning them.

During the development of this martial art, some of the technical elements were discarded or added. Yet, it did not decrease the attractiveness of this sport but, in a way, made it closer to the ordinary person.

2. Methods

2.1 Test group

On the basis of the chosen statistical-mathematical model, i.e. program, goals and hypothesis, it was decided that the sample consists of about 200 athletes (about 100 judoists and about 100 karatists of both sexes) aged between 18 and 27. The majority of this sample had to meet the following criteria:

- ❖ that the effective of the sample was so large that it permitted so many degrees of autonomy that any coefficient in the matrix assembly or any correlation coefficient equal to or larger than .21 could be considered different from zero with the conclusion deviation less than 01;
- ❖ the number of the subjects in the sample had to be five times larger than the number of applied variables so that, according to the recent principles, adequate statistical methods could be applied successfully;

Apart from the aforementioned, the subjects had to meet the following conditions:

- ❖ subjects were male;
- ❖ age was defined on the basis of chronological age, so that the research was performed on subjects from 18 to 27 years of age plus-minus 0.5 years;
- ❖ subjects had regular trainings in their clubs or national team of Serbia, which was confirmed by the evidence of attendance and number of trainings per month;
- ❖ subjects did not have any somatic deformity or aberrations and were physically and mentally healthy.

No other exclusion criteria were used in defining of the population from which the sample of subjects was taken apart from the listed ones.

2.2 Sample of the variables for determining conative characteristics

Measuring instrument CON6 was chosen for assessing conative characteristics by which the following conative regulators were assessed:

- the regulator of activity (EPSILON),
- the regulator of biological functions (XI),
- the regulator of defense reactions (ALPHA),
- the regulator of attack reactions (SIGMA),
- system for coordination of regulative functions (DELTA),
- system for integration of regulative functions (ETA).

2.3 Methods of data processing

CANONIC DISCRIMINANT ANALYSIS IN MAHALANOBIS' SPACE

Canonic discriminant analysis can now be defined as a solution of quazi canonic problem

$$Mx_k = k_k, Gy_k = I_k | c_k = k_k^t l_k = \text{maximum}, x_k^t x_q = y_k^t y_q = \delta_{kq}$$

$$k = 1, \dots, s; s = \min((g - 1), m) = m$$

where δ_{kq} is Kroneker's symbol, and \mathbf{x}_k and \mathbf{y}_k are unknown m -dimensional vectors.

As $c_k = \mathbf{x}_k^t \mathbf{A} \mathbf{y}_k$, the function which is to be maximized is, for $k = 1$

$$f(\mathbf{x}_k, \mathbf{y}_k, \lambda_k, \eta_k) = \mathbf{x}_k^t \mathbf{A} \mathbf{y}_k - 2^{-1} \lambda_k (\mathbf{x}_k^t \mathbf{x}_k - 1) - 2^{-1} \eta_k (\mathbf{y}_k^t \mathbf{y}_k - 1).$$

Differentiating this function by the elements of vector \mathbf{X}_k

$$\partial f / \partial \mathbf{x}_k = \mathbf{A} \mathbf{y}_k - \lambda_k \mathbf{x}_k,$$

and differentiating by the elements of vector \mathbf{y}_k

$$\partial f / \partial \mathbf{y}_k = \mathbf{A} \mathbf{x}_k - \eta_k \mathbf{y}_k;$$

after equaling it with zero

$$\mathbf{A} \mathbf{y}_k = \lambda_k \mathbf{x}_k$$

and

$$\mathbf{A} \mathbf{x}_k = \eta_k \mathbf{y}_k.$$

Differentiating on λ_k and η_k , and from the condition $\mathbf{x}_k^t \mathbf{x}_k = 1$ and $\mathbf{y}_k^t \mathbf{y}_k = 1$, it is easily obtained that $\lambda_k = \eta_k$. As $\mathbf{A}^t = \mathbf{A}$, multiplication of the first result with \mathbf{x}_k^t , and the second result with \mathbf{y}_k^t

$$\mathbf{x}_k^t \mathbf{A} \mathbf{y}_k = \lambda_k$$

and

$$\mathbf{y}_k^t \mathbf{A} \mathbf{x}_k = \lambda_k$$

with $\mathbf{x}_k = \mathbf{y}_k$, the problem is reduced to a simple problem of eigenvalues and matrix \mathbf{A} vectors, that is to the solution of the problem

$$(\mathbf{A} - \lambda_k \mathbf{I}) \mathbf{x}_k = \mathbf{0},$$

$$k = 1, \dots, m$$

so

$$c_k = \rho_k^2 = \mathbf{x}_k^t \mathbf{A} \mathbf{x}_k = \lambda_k,$$

$$k = 1, \dots, m$$

are squares of canonic correlations between linear combinations of variables from \mathbf{M} and \mathbf{G} which are proportional to the differentiation of centroides of subsamples defined by the selective matrix \mathbf{S} in the space between vectors of the variables from \mathbf{M} .

If $\mathbf{p}^2 = (\rho_k^2)$, $k = 1, \dots, m$ diagonal matrix of which the elements are the squares of canonic correlation, if $\mathbf{X} = (\mathbf{x}_k)$, $k = 1, \dots, m$ is matrix of eigenvectors obtained by solving canonic discriminant problem, if

$$\mathbf{K} = \mathbf{M} \mathbf{X}$$

is matrix of discriminant functions and if

$$\mathbf{L} = \mathbf{G} \mathbf{X} = \mathbf{P} \mathbf{M} \mathbf{X}$$

matrix of discriminant functions projected in hypercube defined by vectors of matrix \mathbf{S} .

As

$$\mathbf{K}^t\mathbf{L} = \mathbf{X}^t\mathbf{A}\mathbf{X} = \boldsymbol{\rho}^2$$

and if $\mathbf{K}^t\mathbf{K} = \mathbf{I}$ and $\mathbf{L}^t\mathbf{L} = \boldsymbol{\rho}^2$, canonic discriminant analysis makes two biorthogonal sets of variable vectors by such a transformation of variable vectors from M and G which orthogonalizes those vectors and maximises cone angles between correspondent vectors from K and L under the additional condition that the cone vectors of non-correspondent vectors from K and L equal zero because the correlations between variables K and L are

$$\mathbf{K}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{X}^t\mathbf{A}\mathbf{X}\boldsymbol{\rho}^{-1} = \boldsymbol{\rho}.$$

Vectors \mathbf{x}_k from X are, obviously, vectors of standardized partial regression coefficients of variables from M which generate discriminant functions \mathbf{k}_k which, together with discriminant functions \mathbf{l}_k and vectors formed from standardized partial regression coefficients \mathbf{x}_k from variables G, have maximum correlation. But, as

$$\mathbf{M}^t\mathbf{K} = \mathbf{X},$$

elements of matrix X are, at the same time, correlations of the variables from M and discriminant variables from K which, unlike standard canonic discriminant model, allows simple testing of hypotheses about partial influence of variables on formation of discriminant functions. The elements of cross-structural matrix, defined as correlations between variables M and L, can be of a certain importance for identification of discriminant functions, so the elements of matrix

$$\mathbf{Y} = \mathbf{M}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{A}\mathbf{X}\boldsymbol{\rho}^{-1} = \mathbf{X}\boldsymbol{\rho};$$

observe that Y is factorial matrix of matrix A because

$$\mathbf{Y}\mathbf{Y}^t = \mathbf{X}\boldsymbol{\rho}^2\mathbf{X}^t.$$

As the elements x_{jk} of the matrix X and the elements y_{jk} of the matrix Y are ordinary correlations, their asymptotic variances are

$$\sigma_{x_{jk}}^2 = (1 - x_{jk}^2)^2 n^{-1},$$

that is

$$\sigma_{y_{jk}}^2 = (1 - y_{jk}^2)^2 n^{-1},$$

the hypotheses such as $H_{0x_{jk}}$ or $H_{0y_{jk}}$ can be tested on the basis of the functions

$$f_{x_{jk}} = x_{jk}^2((n - 2)(1 - x_{jk}^2)),$$

or

$$f_{y_{jk}} = y_{jk}^2((n - 2)(1 - y_{jk}^2)),$$

because with such hypotheses these functions have Fisher - Snedecorovu F distribution with the degrees of autonomy $v_1 = 1$ and $v_2 = n - 2$.

Unfortunately, when the standard canonic discriminant analysis is applied, the main, and usually the only set of hypotheses related to parameters of the model is

$$H_0 = \{\varphi_k = 0, k = 1, \dots, m\}$$

in which φ_k are hypothetical values of the canonic correlations within population P.

For testing of the hypotheses type

$$H_{0k}: \varphi_k = 0$$

$$k = 1, \dots, m$$

one function of the well known Wilks' formula is applied

$$\lambda_k = \sum_{t+1}^s \log_e (1 - \rho_{t+1}^2)$$

$$k = t + 1, t = 0, 1, \dots, m - 1$$

which was suggested by Bartlett (1941) who discovered that under hypothesis $H_{0k}: \varphi_k = 0$ function

$$\chi_k^2 = -(n - (m + g + 3)/2)\lambda_k$$

$$k = 1, \dots, m$$

have, approximately, χ^2 distribution with

$$v_k = (m - k + 1)(g - k)$$

degrees of autonomy.

But, the outcomes of Bartlett test are not, even if the large samples are in question, in complete accordance with the outcomes of the tests as

$$z_k \rho_k = \sigma_k$$

$$k = 1, \dots, s$$

which are based on the fact that canonic correlations also have asymptotic normal distributions with parameters φ_k and

$$\sigma_k^2 \sim (1 - \varphi_k^2)^2 n^{-1}$$

(Kendall and Stuart, 1976; Anderson, 1984).

Centroids of subsamples E_p , $p = 1, \dots, g$ from E on discriminant functions, necessary in order to identify the content of discriminant functions, are naturally the elements of the matrix

$$C = (S^t S)^{-1} S^t K = (S^t S)^{-1} S^t M X = (S^t S)^{-1} S^t Z R^{-1/2} X$$

And thus it is evident that they are, in fact, centroids of subsamples on variables transformed into Mahalanobis' shape projected in discriminant space.

3. Results

The reason for the increased number of the reasearches of athletes' personality should be searched for in the characteristics of sport activity, which imposes different requests not just in respect to motor ability, but personality, too. This justifies the assumption that active and successfull participation in sports, including martial arts (judo and karate) demands for specific personality traits which are the most convenient for those sports, or personality traits suitable for sport, and not some other activities too.

Results of the discriminant analysis in conative space are presented in Tables 1-4, and careful analysis shows that only one canonic correlation was discovered (.34) which is significant at level .04.

The first discriminant function is defined by mechanism for integration of regulatory functions, mechanism for coordination of regulatory functions, mechanism for control of defence and mechanism for control of organic functions, and finally activity regulator, which at the same time models activating part of reticular formation, which is itslef responsible for energy level at which other systems, including cognitive and motor processors, function.

Based on the size and precursors of the centroids for the first discriminant function of groups, we can conclude that: judoists are able to adequatly model tonic excitement on the basis of programs transfered by genetic code or formed by learning, which are located in centres for regulation and control of reactions of defence and attack. They are capable to coordinate functionally and hierarhically different subsystems, both cognitive and conative. Karatists are capable of adequately modelling excitatory-inhibitory processes because control of strikes is necessary for that sport and it is required by strict rules of this sport.

Table 1 DISCRIMINANT ANALYSIS OF CONATIVE VARIABLES

F	Kan. R.	Λ	χ^2	df	Sig.
1	.34	,97	12,98	6	,04

Table 2 STRUCTURE OF CANONIC FACTOR IN H SPACE

Variables	D1
EPSILON	,43
XI	-,67
ALPHA	,17
SIGMA	-,39
DELTA	,38
ETA	,99

Table 3 GROUP CENTROIDS

Grups	D1
Judo	-.34
Karate	.31

Table 4 STRUCTURE OF CANONIC FACTOR IN Z SPACE

Variables	D1
ETA	,85
DELTA	,59
ALPHA	,48
XI	,37
EPSILON	,33
SIGMA	,07

4. Conclusion

The research was conducted with the aim to investigate specificities of conative dimensions in athletes who practice judo and karate and to determine the differences between them.

In order to determine specificities of the structure of tested anthropologic dimensions, 200 judoists and karatists, members of judo and karate clubs in Serbia (around 100 judoists and around 100 karatists), between 18 and 27 years of age, were tested.

Measuring instrument KON6 was chosen for evaluation of conative characteristics, and by means of it the following conative regulators were tested: activity regulator, organic function regulator, defence reaction regulator, attack reaction regulator, system for coordination of regulatory functions and system for integration of regulatory functions.

All the data in this research were processed in the Centre for Multidisciplinary Research of the Faculty of Sport and Physical Education, University in Priština, by means of the system of programs for data processing developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003).

Complete algorithms and programs from this dissertation have been presented, and the results of those programs analyzed.

Results of the discriminant analysis in conative space are presented in Tables 1-4, and a careful analysis of them shows that only one significant canonic correlation was observed (.34), which was significant at level .04.

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According to the size and precursors of centroids for the first discriminant function of groups we can conclude that: judoists are capable of adequately modelling tonic excitement based on the programs transferred by genetic code or formed under the influence of learning, which are located in centers for regulation and control of reactions of defence and attack. They are capable of coordinating functionally and hierarchically different subsystems, both cognitive and conative. Karatists are capable of adequately modelling excitatory-inhibitory processes since that sport control of strikes is necessary, which is also required by strict rules in this sport.

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Summary

The research was conducted with the aim to investigate specificities of conative dimensions in athletes who practice judo and karate and to determine the differences between them.

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Complete algorithms and programs from this dissertation have been presented, and the results of those programs analyzed.

Results of the discriminant analysis in conative space are presented in Tables 1-4, and a careful analysis of them shows that only one significant canonic correlation was observed (.34), which was significant at level .04.

The first discriminant function is defined by mechanism for integration of regulatory functions, mechanism for coordination of regulatory functions, mechanism for control of defence and mechanism for control of organic functions, and finally activity regulator; which at the same time models activating part of reticular formation, which makes it responsible for energy level at which all other systems function, including cognitive and motor processors.

According to the size and precursors of centroids for the first discriminant function of groups we can conclude that: judoists are capable of adequately modelling tonic excitement based on the programs transferred by genetic code or formed under the influence of learning, which are located in centers for regulation and control of reactions of defence and attack. They are capable of coordinating functionally and hierarchically different subsystems, both cognitive and conative. Karatists are capable of adequately modelling excitatory-inhibitory processes since that sport control of strikes is necessary, which is also required by strict rules in this sport.