3rd International Scientific Conference
Opatija, Croatia, September 25-29, 2002

KINESIOLOGY NEW PERSPECTIVES

Proceedings Book

Editors-in-Chief:

Dragan Milanović and Franjo Prot

Organiser:
Faculty of Kinesiology, University of Zagreb

Under the patronage of:
Croatian Academy of Sciences and Arts

Faculty of Kinesiology, University of Zagreb
Zagreb, 2002

FACTOR IDENTIFICATION OF THE ACTUAL MECHANISMS OF SPECIFIC MOVEMENT REGULATION

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Introduction

The systems of variables that belong to virtually different spaces are frequently used within the existing models of planning and programming specific transformational processes. In this way it is possible to describe some entities by the sets of variables that are reciprocally related by means of the appropriate canonical or regression procedures. The conclusions drawn on the basis of data obtained in this way are, however, often debased by an extremely high level of overlapping of particular pieces of information. This happens because the same factors or mechanisms of higher order structuring affect more than only one set of variables, especially under standard linear models [1,2]. Consequently, conjectured results or, at least, the results that can be interpreted but that cannot be directly applied, are obtained. Before the commencement of procedures by means of which such sets of variables are reciprocally related, a simple way should be found to check if these mechanisms are in some subspaces redundant, and thus make the data sufficiently objective to relieve them of the burden of multiple overlapping of the pieces of information. Probably the simplest way to do this is the factorisation of each individual subspace and consequently the factor analysis of the latent variables obtained in this way. In that sense, the aim of this study was to generate a simple analytic model to reveal existing higher order mechanisms of a movement regulation.

Materials and methods

To check the model of identification of the actual movement regulation mechanisms, the data were used that had been obtained by the measurements carried out on 155 girls aged 13. After several years of training in a handball school the sample was described by 41 variables from three virtual subspaces – the morphological space, the motor space and the space designated by the situation-related variables in handball. The morphological status was assessed by 13 measures in accord with the international biological programme: body height (AVIS), leg length (ADUN), arm length (ADUR), elbow diameter (ADIL), wrist diameter (ADRZ), knee diameter (ADIK), upper arm circumference (AONL), forearm circumference (AOPL), lower leg circumference (AOPK), body weight (ATEZ), upper arm skinfold (ANNL), back skinfold (ANLE) and abdominal skinfold (ATRB). The motor status was assessed by 13 motor variables that were determined in such a way as to fully cover the dimensions of movement frequency, explosive strength, coordination and dynamic strength: hand-tapping (MTAP), foot tapping (MTAN), arm circles (MKRR), leg circles (MKRN), long jump from a standstill (MSDM), throwing the medicine ball from supine position (MBML), two-ball leg-dribble slalom around an upright (MSNL*), hitting the ball up with a table-tennis racket (MORE), juggling the match boxes (MZON), floor dexterity (MONT*), polygon backwards (MPOL*), sit-ups (MCDT) and dips (MSKM). Specific handball-related status was assessed by 15 tests intended to cover accuracy, ball manipulation, the speed of moving with and without the ball, and the strength of throwing the ball – bouncing the ball (throwing the ball and catching it) off the wall (HKR1), ball manipulation with eyes closed (HKRP), bouncing the ball with two hands while jumping (HRK2), 20m run from a standing start (HRB2*), slalom dribbling the ball (HRBL*), figure-of-square dribbling the ball (HRBV*), mobility of a player without the ball along the sidelines of the court and also longitudinally towards the opponent's goal (HRBB*), the speed of slalom running without the ball (HRBT*), execution of a defensive task without the ball (HRXO*), accuracy of shooting at the goal during the fall from the seven-metre line (HRP7), accuracy of jump-shooting at the goal from the nine-metre line (HRP9), accuracy of the off-the-dribble shooting at the goal from the 8-m distance (HRP8), the power of distance throwing the ball from the fall (HRSP), the power of distance throwing the ball from the jump (HRSS) and the power of distance throwing the ball from the floor (HRST). All measurements were carried out by qualified people – physical education teachers. The data were processed under the standard statistical procedures [3] and Hotelling principal components factor model with an orthoblique transformations [2]. The asterisk designates the variables in which the lower result denotes a better result.

Results and Discussion

In the first step of the analysis two clearly defined oblique factors in the morphological space were obtained: 1. body weight with the insignificantly expressed body fat mass (AM) and 2. longitudinality (AL). Four factors were identified in the motor space: 1. movement frequency (MF), 2. coordination (MK), 3. dynamic strength (MR) and 4. explosiveness (ME). In the space of specific handball-related measures three clear factors were obtained: 1. speed of movement and the power of throwing (SK), shooting at the goal (SS) and 3. ball manipulation (SM). The correlations between these factors are presented in Table 1.

At the second step of the analysis, it is evident that the correlations between oblique factors are mostly statistically significant, although their values fall in the range between the lowest (0.16, …) and the ones that are high (0.66). This testified to the relationship between the factors obtained by means of separate analyses. Table 2 displays the orthoblique position obtained from the nine previously described dimensions.

Table 1. Correlation between the morphol. (A ...), motor (M ...) and specific (S ...) factors.

	AM	AL	MF	MR	MK	ME	SK	SS	SM
AM	1.00	**0.48**	-0.09	**0.16**	**-0.18**	-0.02	-0.08	**0.21**	0.05
AL	**0.48**	1.00	**0.30**	**0.38**	0.09	**0.45**	**-0.47**	**0.42**	**0.24**
MF	-0.09	**0.30**	1.00	**0.44**	**0.34**	**0.57**	**-0.40**	0.15	**0.27**
MR	**0.16**	**0.38**	**0.44**	1.00	**0.28**	**0.50**	**-0.50**	**0.37**	**0.36**
MK	**-0.18**	0.09	**0.34**	**0.28**	1.00	**0.35**	**-0.34**	**0.19**	**0.23**
ME	-0.02	**0.45**	**0.57**	**0.50**	**0.35**	1.00	**-0.66**	**0.46**	**0.42**
SK	-0.08	**-0.47**	**-0.40**	**-0.50**	**-0.34**	**-0.66**	1.00	**-0.49**	**-0.39**
SS	**0.21**	**0.42**	0.15	**0.37**	**0.19**	**0.46**	**-0.49**	1.00	**0.50**
SM	**-0.27**	-0.08	0.12	0.14	**0.28**	**0.28**	-0.04	**0.38**	**0.23**

Table 2. The orthoblique position and the correlation between the orthoblique factors.

	OBQ1	OBQ2	OBQ3
AM	-0.07	(0.89)	0.03
AL	0.52	(0.66)	-0.04
MF	(0.97)	-0.11	-0.41
MR	(0.70)	0.14	0.01
MK	(0.68)	-0.45	0.03
ME	(0.81)	-0.05	0.09
SK	(-0.67)	-0.05	-0.21
SS	0.10	0.13	(0.79)
SM	0.12	-0.17	(0.79)
	OBQ1	OBQ2	OBQ3
OBQ1	1.00	0.20	0.28
OBQ2	0.20	1.00	0.20
OBQ3	0.48	0.20	1.00

As it is evident, the three orthoblique factors are all in correlation that is not only of the same approximation, but also of almost the same values. This provides us with the evidence about the well-grounded structures of higher order mechanisms, which is extremely important for drawing the conclusions about the existence of 9 treated mechanisms obtained from three independent factor analyses (step one). It is also apparent that the first orthoblique factor is unmistakably the motor one, that the second factor is indisputably the morphological one, and that the third describes the space of specific measures.

What is obvious are the almost zero projections of 9 dimensions outside the orthoblique factors of the primary definition, which proves that the project was excellently planned. Still, one of the nine dimensions was not projected as expected. Namely, the projection of the specific dimension SK that describes the movement with and without the handball and the power of throwing the ball (specific movenet) was more expressed on the motor factor. It was even significantly projected on the morphological factor, whereas its projection on the factor denoting specific movements in handball was zero. Such situation is, naturally, possible. This is precisely the situation because of which this model was designed. The 'SK' dimension, obtained in the previous phase of the analysis, although extracted with the intention to describe specific movements, is apparently so saturated in motor terms that in the analysed sample it may not be in any way treated as a specific movement, that is, the mechanism on which the results in some specific movement realisation manifestations depend. This dimension is simply not a specific movement-related dimension and it cannot describe anything that is considered to be specific for the issue in question. Simply said, those young female athletes who achieved the higher test values of general motor manifestations will use their capacity to achieve better results in what at first sight appears to be the acquired technique. This is an interesting piece of information that can be exceptionally significant for planning and programming the training process, since it is not ruled out that such a situation is rather frequent, and although everything seemingly appears to be in order, the appropriate and expected results permanently fail to occur. The perfectly simple procedure suggested in this paper may in all situations of this type literally shed light upon the further possible directions of investigation, both in programming the training process and in the process of selection.

Conclusion

When a sample is described by means of the variables from two or more virtually different spaces (morphological, motor, cognitive and particularly the specific space) the appearance of redundant pieces of information is possible in everyday situations. These situations may be resolved by means of multifactorial experiments, multiple analyses of covariance, canonical models and the like. However, there will always be some dilemmas as regards the actual existence of higher order mechanisms that are responsible for manifestations in these virtual subspaces. A simple model was, therefore, suggested that is based on the factorisation of each individual subspace, and consequently, on the factor analysis of latent dimensions obtained in this way.

On a sample of 155 young female athletes measured by 13 morphological, 13 motor and 15 handball-specific variables, it was found that the suggested model revealed a high degree of redundancy of the motor set, the first out of the three specific factors.

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