LATENT STRUCTURE OF AGILITY OBTAINED BY A BATTERY OF TESTS

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Abstract:

The aim of the research was to analyse the latent structure of agility obtained by a battery of motor tests aimed at assessing agility. A comprehensive battery of 32 motor tests was designed, including most tests already used in investigations of motor phenomena and/or in sports training practice, as well as a certain number of original tests, created particularly for this research. A sample of 152 freshmen (male PE teacher students, aged 20.2 ± 0.8 yrs) from the Faculty of Kinesiology University of Zagreb, Croatia, participated in the study. Seven significant principal components were extracted from the factorized matrix of intercorrelations among the agility tests. These dimensions were then transformed into two oblique parsimonic solutions by means of the promax and orthoblique factor solutions. Both analyses resulted in numerically simple and very similar solutions, which additionally enhanced the reliability of the isolated dimensions. Out of the seven isolated factors, the first five were sensibly interpretable. The obtained latent dimensions were named in descending order as: 1) agility in the multiple changes of movement directions within a small space; 2) agility in simple frontal and lateral movements; 3) agility in twist movements; 4) agility in frontal and lateral movements with changes of direction of up to 90°; 5) agility in frontal movements with changes of direction over 90°. The study revealed that the space of agility is far more complex than it is commonly regarded among experts in the area of motor phenomena, i.e. kinesiologists or sport scientists. Therefore, the space of agility should be further and more profoundly investigated. The anticipated findings may be very useful not only to researchers in the area of general motor abilities, but to researchers and practitioners in all disciplines of applied kinesiology as well, especially those in which agility is an important component of performance and sport achievement.

Key words: *agility, motor tests, factor analysis, latent dimensions*

DIE MITTELS EINER TEST-BATTERIE ERHALTENE LATENTE STRUKTUR DER GEWANDTHEIT

Zusammenfassung:

Diese Untersuchung wurde unternommen, um die latente Struktur von Gewandtheit auf Grund einer Batterie von motorischen Tests zu analysieren. Zu dem Zweck wurde die aus 32 Tests bestehende Batterie aufgelistet, die einerseits alle schon früher in Untersuchungen der Erscheinungsformen der Bewegungen und/oder in Sport-Trainings angewendeten Bewegungstests, aber auch eine Anzahl von zu dieser Untersuchung entfalteten Tests beinhaltete. Als Stichprobe für die Untersuchung galten 152 Studenten aus ersten zwei Semestern des Studiums an der Fakultät für Kinesiologie in Zagreb. Auf Grund von Faktorenanalyse der Interkorrelationsmatrix von Tests für Gewandtheitsfeststellung wurden sieben Hauptkomponenten ermittelt. Das Betreffende wurde in zwei schiefwinklige Parsimonlösungen transformiert durch Anwendung von Promax- und Orthoblique-Ermittlungen. Beide Analysen erzielten numerisch einfache, ziemlich miteinander übereinstimmende Lösungen, was weiterhin die Glaubwürdigkeit von isolierten fortdauernden Dimensionen bewies. Von sieben ermittelten Faktoren waren nur erste fünf interpretierbar. Die isolierten fortdauernden Dimensionen wurden nach vorher genannten Aufeinanderreihung folgendermaßen bezeichnet: 1) Gewandtheit

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bei der Durchführung von Veränderungen der Bewegungsrichtungen auf beschränktem Feld; 2) Gewandtheit, bedingt von einfachen Frontal- und Lateralbewegungen; 3) Gewandtheit in den Rotationsbewegungen; 4) Gewandtheit, bedingt von einfachen Frontal- und Lateralbewegungen mit Richtungsveränderungen unter 90 Grad; Gewandtheit, bedingt von einfachen Frontalbewegungen mit Richtungsveränderungen über 90 Grad. Aus der Untersuchung kam ersichtlich heraus, dass der Gewandtheitsraum bedeutend komplexer ist, als von den Fachleuten für motorische Erscheinungsbilder angenommen. Daher wäre der Raum näher zu untersuchen, weil die gewonnenen Erkenntnisse von Bedeutung wären – sowohl auf dem Gebiet der allgemeinen motorischen Fähigkeiten wie auch für die angewandte Kinesiologie, wo die Gewandtheit einer der bedeutendsten Zügen für sportliche Leistung und Sporterfolgen ist.

Schlüsselwörter: *Gewandtheit, motorische Tests, Faktorenanalyse, fortdauernde Dimensionen*

Introduction

Frequent and quick changes of movement direction are the building blocks of structure in most of polystructural and complex sports. The most conspicuous motor or movement ability in the background of such movement patterns is known as agility (from Greek *agilis* – mobile, alert, quick, dexterous, swift, brisk). For the sake of sport practice, physical conditioning in particular, agility may be defined as the human ability to displace the body in space quickly and efficiently under the conditions of repeated performance of sudden stops and changes of direction.

Agility is also defined as: 1) the ability to change the direction of movement quickly (Gredelj, Metikoš, Hošek & Momirović, 1975); 2) the ability to accelerate, decelerate, and change direction quickly while maintaining good body control without decreasing speed (Brittenham, 1996; Graham, 2000); 3) the ability to quickly change the direction of movement without jeopardising balance, speed, power, and control of movement (Pearson, 2001); 4) the ability to perform quick, well-coordinated, linked (fluid) changes of movement direction (Drabik, 1996); 5) the ability to effectively perform movements of the "stop-and-go" type, embracing stops, reactive-elastic movements and explosive starts (Flisk, 2000).

Eventual sport success in numerous sports depends highly on the efficient and quick displacement of the body in space. According to the opinion of many experts in team and combat sports, agility is one of the most important biomotor abilities with the highest contribution to top quality performance and outstanding sport accomplishments (Bompa, 1999; Graham, 2000). Certain experts even claim that the particular sport of theirs is primarily an agility event (Trninić, Marković & Heimer, 2001), therefore much lower evaluation coefficient values are assigned to the rest of the abilities and attributes, as well as to various technical-tactical skills.

The position of agility in general motor space has so far been addressed in miscellaneous ways. Gredelj and associates (1975) include agility among the abilities subjected to the mechanism responsible for movement structuring, together with coordination abilities and speed of alternate movements. Bompa (1999) understands agility as a combination of the basic abilities of speed and coordination. Recently, in literature sources dealing with strength training and conditioning (Pearson, 2001; Graham, 2000), agility usually shares context with *speed* and *quickness* (speed, agility and quickness – SAQ). Verstegen and Marcello (2001) also aligned agility in close structural and training relationship with coordination and these two abilities are called a building block of graceful sporting performance. These authors presented an interesting structure of relationships among agility and the rest of physical abilities, components of fitness and conditioning (preparedness). Agility significantly depends on or is closely related to the following factors: coordination, mobility of joint systems, dynamic balance, power, elasticity, energy system development, stabilizing and propulsive strength, speed, stability of locomotor system, and optimal biomechanical movement structure patterns. The same authors present agility as an ability which permits an athlete to react to a stimulus, start quickly, move in the desired direction, be ready to change direction or stop quickly, and to perform fast, smooth, efficient and repeated movements.

Pearson (2001) speaks about the four basic elements of agility: balance, coordination, programmed agility (known environmental conditions) and randomized agility (unknown environmental conditions). Gambetta and Winckler (2001) expanded the list of components which the manifestation of agility depends on as follows: reaction and situation recognition, starting position, starting acceleration, the first step quickness and power (movement impetus), acceleration, body control

in fast performance, catching up with and outrunning the opponent, foot-work, change of direction, performance of feints, avoiding the opponent, space orientation and reaction, and halting.

Very often agility is mentioned in the context of sport injury prevention (Gambetta &Winckler, 2001; Graham, 2001). It is generally considered that athletes with pronounced agility have a better body control in urgent training and competition situations.

It should be accentuated here that in actual competition high efficiency of situational, sport-specific agility is considerably determined by volume and the developmental level of technical-tactical skills (knowledge). It concerns particularly the type of motor knowledge which allows an athlete to apply any adequate "feints/fakes" in precise timing in order to drive the opponent into situations unfavourable for optimal motor performance. When agility assumes a sport-specific and situation-related character, we usually speak about agility with and/or without the manipulation of implements. In that case the basic competition implement considerably determines the most typical modes of movement, in which agility is also manifested.

The present study, basically a kind of a preliminary investigation, is an attempt to find answers to some of the mentioned issues related to the structure of agility. Hence the major goal of the research: to determine the latent structure of a number of motor tests aimed at assessing agility.

Methods

Sample of participants consisted of 152 PE teacher students (age 20.2 ± 0.8 years), freshmen from the Faculty of Kinesiology University of Zagreb, Croatia. It had been drawn from the population of physically active young men who can be considered as positively selected from the aspect of functional and motor abilities and morphological characteristics. The results of the investigation can be extended or generalised onto a population of similar attributes.

Sample of variables. A battery of 32 motor tests, assessing the ability of agility, was designed for the sake of the study. Scores in all the applied measuring instruments were expressed in terms of time (seconds) needed for a successful performance in a particular motor task. (The lower the scores, the better the results.) Each task was performed three times and all the measurements were taken into account when computing the final test results. The entire agility test battery embraced:

a) agility tests already utilized for the same purpose in previous research studies;
b) agility tests being used in certain sports for the purposes of selection and/or designing training programmes;
c) original agility tests constructed for the purpose of the present research exclusively.

The tests employed are here described in the shortest possible way and in the order that corresponds to the sequence of their occurrence in the matrices:

1. Lateral steps (MAGKUS) – shuffle side steps side-to-side between parallel lines 4m apart (6 lengths in total).

2. Stride steps forward-backward (MAGNN2) – straight line movements (steps forward and backpedal) between parallel lines 2m apart (6 lengths in total).

3. Lateral steps along the circle line (MAGKSP) - shuffle side steps along the outer side of a quarter of the circle 360cm in diameter (6 lengths in total).

4. Single leg hops forward-backward (MAG1NN) - straight line hops forward-backward (hands on the back) between parallel lines 2m apart (6 lengths in total).

5. Lateral steps over various distances (MAGKND) – shuffle side steps side-to-side between parallel lines distanced unevenly (6 lengths in total; Figure 1). The test is similar to the 40-yard test.

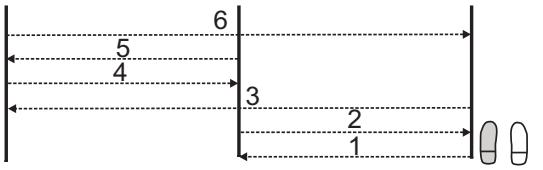

Figure 1. Scheme of the test MAGKND.

6. Single leg lateral hops (MAGJNB) – single leg side hops side-to-side between parallel lines 2m apart (6 lengths in total).

7. Figure of eight with ducking (MAGOSS) – movements between and around two cones or stands 4m apart connected by elastic ribbon at the participant's shoulder height; a subject should run a figure of eight and duck when passing under the ribbon. The task is completed when two figures are performed (Metikoš, Hofman, Prot, Pinter & Oreb, 1989).

8. Moving ahead with front turns of 180° - front pivot (MAGRNP) – a subject stands at the starting line and covers a 2m distance side-to-side by performing forward twists of 180° and returns in the same way (six times a 2m distance in total; Figure 2).

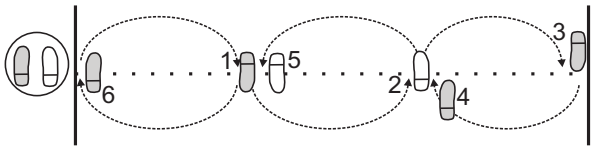

Figure 2. Scheme of the test MAGRNP.

9. Moving ahead with back turns of 180° - back pivot (MAGRNT) – a subject stands at the starting line and covers a 2m distance side-to-side by performing rotations of 180° backward along the longitudinal body axis and returns in the same way (six times a 2m distance in total; Figure 3).

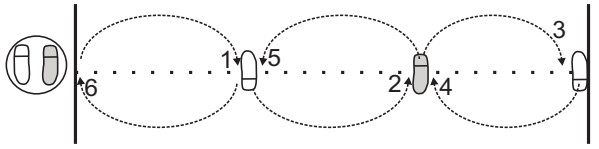

Figure 3. Scheme of the test MAGRNT.

10. Single leg hops forward-backward, hands free (MAGJNN) - straight line hops (hands free) between parallel lines 2m apart (6 times in total). The task is completed when the subject has covered the 2m distance for the sixth time.

11. Running forward-backward with full turns (MAG360) – a subject runs forward and pedals back between parallel lines 2m apart and on an each line he performs a 360° twist (full turn). The task is completed when the testee has covered the 2m distance for the sixth time.

12. Moving inside a semicircle (MAGOBR) – a subject assumes a basic parallel stance in the middle of a semicircle 360cm in diameter with his back to the semicircle. He performs the predetermined combination of backpedalling, movements along the circle line and lateral steps (Figure 4).

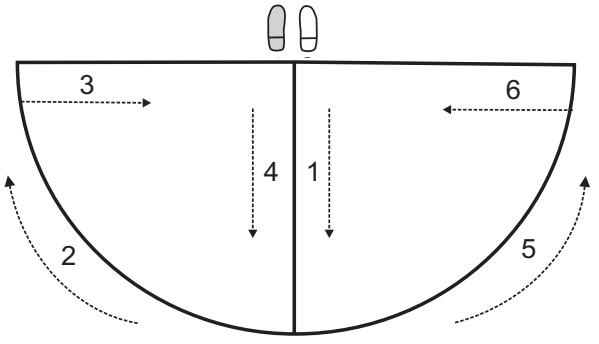

Figure 4. Scheme of the test MAGOBR.

13. Moving in four directions inside the circle (MAG4SM) – a testee performs the predetermined combination of movements sideways and forward-backward within the circle 360cm in diameter (Figure 5) with no change of face orientation.

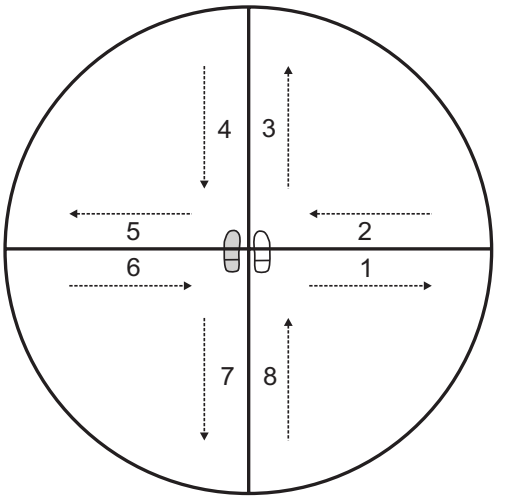

Figure 5. Scheme of the test MAG4SM.

14. Running and rolling sideways (MAGVAL) – a subject starts by standing beside a mat (3x2m). He should roll sideways (over one shoulder first) to the opposite side of the mat, run around it to the starting point, roll again (over the other shoulder now), run around the mat by the other side and end the task with the third roll.

15. Running with rolls backward (MAGKON) – a subject stands with his back to a mat (3 x 2 m). He performs a backward roll, stands up, runs around the mat to the starting point, performs the second roll backwards, runs around the mat by the other side to the starting point, and completes the task with the third roll.

16. Running in a rectangle (MAGTUP) – a testee moves acording to the predetermined pattern turning around 5 stands (4 at four angles of a rectangle 4 by 5m and one is in the intersection of diagonals) (Figure 6). Similar to the 5-dot drill.

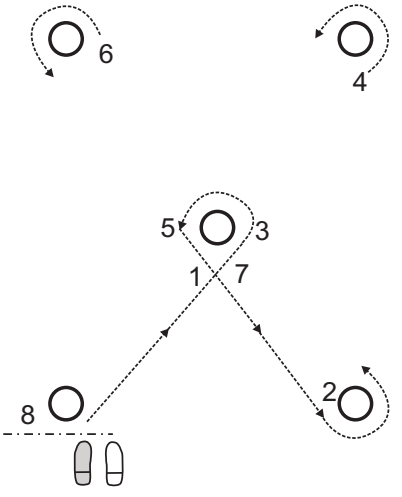

Figure 6. Scheme of the test MAGTUP.

17. Triple side-to-side with front-back turns (MAGCRO) – a subject performs twists and moves lineary over a 4m distance by combining alternate 180° turns forwards and backwards, starting with a front half-turn (Figure 7). The task is completed after the sixth coverage of the distance.

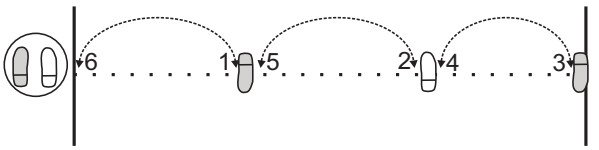

Figure 7. Scheme of the test MAGCRO.

18. Basic basketball movements (MAGOKK) – a combination of piston and two-point stance movements forwards, backpedal and sideways along the circle line at the free-throw line (Figure 8).

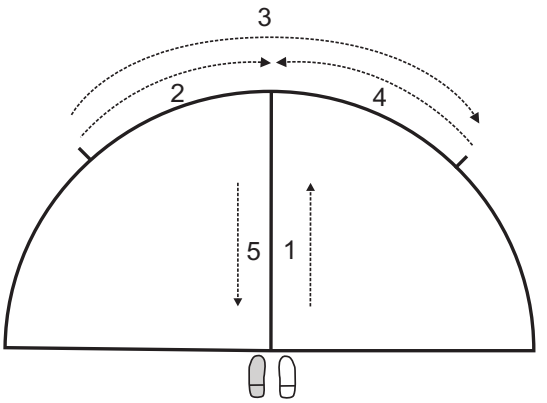

Figure 8. Scheme of the test MAGOKK.

19. 20-yard shuttle test (MAG20Y) – the standard test for assessing agility developmental levels in NBA basketball players (NBCCA, 1997). A subject stands in a two-point stance straddling the starting line (sideways to the side lines) at the middle of the 10yrd distance. On a measurer's signal, he turns to one of the side lines 5 yrds apart, sprints to it, touches the side line with his hand, turns to the other side line, sprints to it, touches it, turns back and sprints 5 yrds back through the start (middle) line to finish.

20. 20-metre square (MAG4X5) – a testee sprints in a figure of a square around 4 cones or stands 5m apart.

21. Hexagon test (MAGHEX) – the standard test for assessing agility in NBA basketball players (NBCCA, 1997). Double-legged leaps are performed from the middle of the hexagon (each side is 60 cm long) and back. Always facing the starting direction of movement, a subject jumps outside each side of the hexagon and back.

22. Run and pivot (MAGPIV) – a subject covers a 2m distance four times and performs a back pivot at the finish of an each coverage.

23. Slalom (zigzag) run (MAGSLA) – a testee runs through 5 stands or cones, set in a straight line 2m apart each, and returns to the start in the same way (Figure 9).

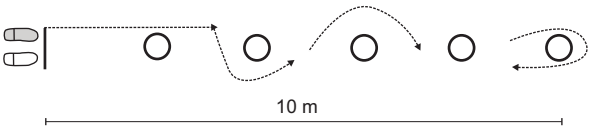

Figure 9. Scheme of the test MAGSLA.

24. Running forward along the three-point line (MAGTRI) – a subject performs a predetermined pattern of movements forwards by covering back and forth the predetermined sections (with half turns) along the three-point line on the basketball court (Figure 10). On the marked points he turns by 180°.

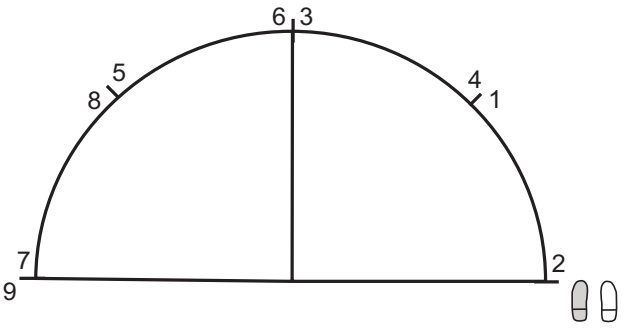

Figure 10. Scheme of the test MAGTRI.

25. Simulating "boxing attack and retreat" (MAGBOX) – three points are marked on the floor in the a shape of the equilateral triangle (1.5 m). A subject stands in one of the "triangle" points on the right leg. On a timekeeper's signal he jumps with his left leg on to the left point, jumps back to the starting point with the right leg, quickly changes the standing leg, jumps to the right point with the right leg and jumps back to the starting point with his left leg. The task is completed after the three described cycles.

26. Slalom with back pivots (MAGSLO) – a subject should cover the zig-zagged stand course so as to change the direction of movement by a back pivot in front of each stand (Figure 11).

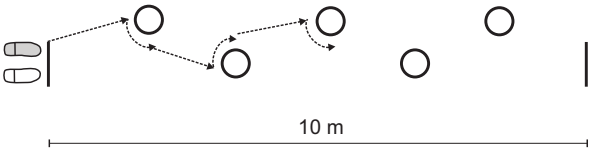

Figure 11. Scheme of the test MAGSLO.

27. Single leg hexagon (MAGHX1) – a modification of the standard hexagon test; a testee should hop to the hexagon sides first on one leg, then on the other.

28. Lateral movement (side shuffle) along the circle line with the back to the centre of the basketball court (MAGKRB) – a subject stands on a mark on the circle in the centre of the basketball court with his back to the centre of the circle. The task is to shuffle sideways along the circle to the starting point. The outer rim of the circle should not be crossed over.

29. Single leg hops in three directions (MAGTJS) – a subject stands on one leg on the marked spot. Half a metre (0.5m) ahead and on his left and right from the spot three lines are marked on the floor. He should perform a predetermined combination of linked single leg hops over the marked lines with each leg in turn (Figure 12).

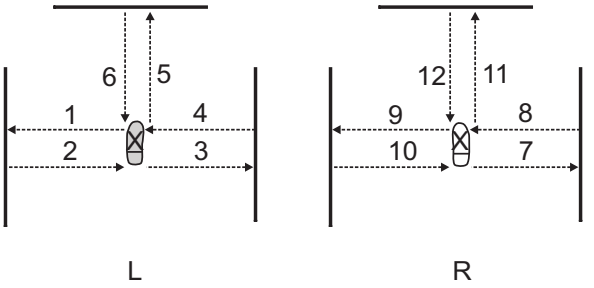

Figure 12. Scheme of the test MAGTJS (L and R represent movement patterns of the left - L and right - R leg).

30. Single leg hops around the boxes (MAGO2S) – a subject stands on the end of the 1m line. Two boxes are on the left and right side of the line. He should hop on his right leg around the right box to the other end of the line, come back to the starting point, then, with no interruption, repeat the task with his left leg around the left box (Figure 13).

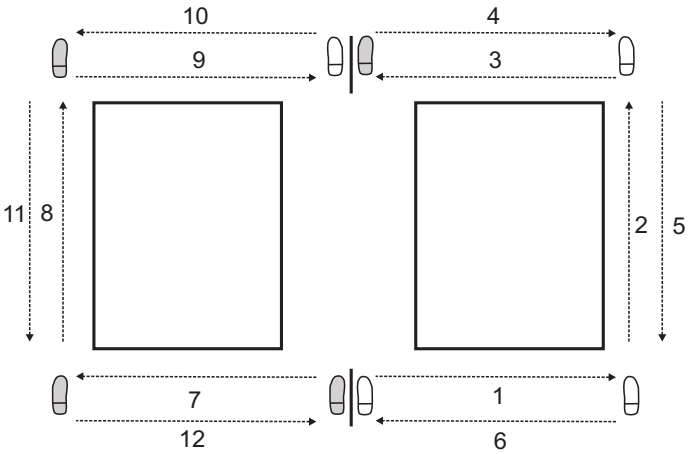

Figure 13. Scheme of the test MAGO2S.

31. Slipping under a ribbon imitating punch-avoiding movements (MAGPOD) – a subject should perform the predetermined combination of movements forwards-backwards combined with slipping under an elastic ribbon and imitating punch-avoiding movements from combat sports (e.g. boxing; Figure 14). The distance between the stands was 2m and the height of the ribbon was set at shoulder height for each testee.

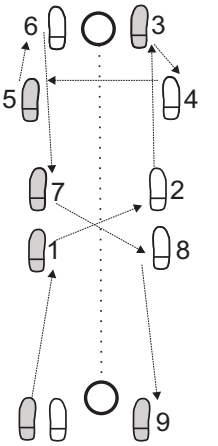

Figure 14. Scheme of the test MAGPOD.

32. Double leg hexagon (MAGHX2) – a modification of the standard test for assessing agility in NBA basketball players (NBCCA, 1997). Double-legged leaps over each side of the hexagon are performed from the middle of the hexagon and back, but this time the subject always faces the direction of movement.

Data processing methods. Three successive measurements were performed in each and every of the 32 tests. The final results in the single tests were obtained by means of condensing the scores to the first principal component of the internal inter-item correlation matrices. The intercorrelation matrix of the agility tests was computed afterwards and subjected to the exploratory procedure of factor analysis. The variances of the principal components were calculated, as well as their partial and cumulative contributions to the total variability of the analysed space. A number of significant factors was determined by the PB-criterion (Štalec & Momirović, 1971). Then the matrix of correlations of the agility tests with the significant principal axes was computed, as well as communality of each test. Orthogonal system of significant principal components was transformed into two different oblique solutions (orthoblique and promax) by means of the Kaiser's normalization procedure. The final results of the applied factor analyses are

presented in the matrices of pattern and structure of both the orthoblique and promax factors, as well as in the matrices of correlations among the factors obtained by means of the two solutions. Congruencies among the promax and orthoblique factors were computed in the end to get a more thorough insight into the structure and stability of the latent dimensions of the analysed space.

Results and discussion

This prolegomenous research study presents and deals with only a part of the results obtained by the applied analyses[1]. Table 1 displays the total of variances of the significant principal components, as well as their partial (% of Var) and cumulative (Cum %) share in the total variability of the investigated space. It is obvious that as many as seven latent dimensions were needed to explain the total variability and covariability of the 32 investigated tests. This fact indicates, however, that this segment of the motor space is far more complex than it is usually considered in the circles of kinesiologists or sport scientists. Still, the magnitude of the first principal component (30.51%), which explains over 30% of the total variability, which, in this case, is as much as the rest of the 6 components (together they exhaust 33.2%), distinctly indicates that, in the entire space of agility tests, there exists a dimension with attributes of the general ability factor.

Table 1. Eigenvalues and variances of the isolated principal components

Component	λ	% of Variance	Cumulative %
1	9.76	30.51	30.51
2	2.62	8.19	38.70
3	2.25	7.03	45.74
4	1.60	5.01	50.74
5	1.50	4.70	55.44
6	1.41	4.39	59.83
7	1.24	3.88	63.71

Structure of the significant principal components and magnitudes of variances of the agility tests, which can be explained by latent factors (communalities), are presented in Table 2.

Most agility tests established their maximal positive correlations with the first principal component, whereas seven variables established their maximal correlations with one among the rest of the isolated components. Values of correlative relations range from 0.21 to 0.74, with 12 variables having correlations lower than 0.5, and 12 tests having correlations above 0.6. It can be said, then, that most of the agility tests are under considerable influence of a general factor of agility, whereas almost one third of the tests is under a stronger influence of more specific dimensions. So, the influence of the general factor of agility is obviously equivocal and it does not occur as the predominant contributor to the variability formation in all the utilized agility tests. This is somewhat unexpected because the presumption that general or basic agility exists was inherent to the process of designing and applying the tests. The presumed general agility should have determined significantly the basic measurement object of all the applied variables. The finding may make the process of identification of basic generators of variability in all the seven latent diemensions more difficult and uncertain. However, vectors of communalities clearly indicate that the seven isolated dimensions explain a relatively high percentage of variances in a large number of variables. According to the latter, it is highly probable that the latent dimensions would be well defined. Values of communalities range from 0.48 to 0.79, with only one variable having the communality lower than 50%, and with 22 variables in which the explained portion of variance exceeds 60%. The latter values should be considered as satisfactory for the tests which are, in fact, standardized motor manifestations of a relatively high complexitiy.

Tables 3, 4, 5 and 6 contain information crucial for the identification of the isolated dimensions, which is the primary aim of the present research. This body of information is interpreted simultaneously by means of integrating the information contained in various tables. It regards the matrix of pattern (Table 3), matrix of structure (Table 4), matrix of intercorrelations among the factors (Table 5) and matrix of congruence between the promax and orthoblique factors (Table 6). All the listed tables are structured so as to display, side by side, the solutions obtained by both factor analyses, thus enabling a full-scale insight into the differences and similarities between the promax and the orthoblique solutions. To facilitate the process of comparison, the sequence of the orthoblique factors was adjusted to the sequence of the promax factors in all the tables - the most congruent orthoblique factors are associated with the promax factors in the tables of pattern and structure, whereas in the table of correlations among the factors the promax factors are positioned in the upper part of the table,

[1] The rest of the obtained results are available from the author responsible for correspondence.

Table 2. Structure of the principal components and communalities of variables

	1	2	3	4	5	6	7	COM
MAGKUS	0.51	-0.31	-0.41	0.00	0.01	0.19	0.22	0.61
MAGNN	0.64	-0.37	-0.31	-0.03	-0.15	0.17	0.05	0.69
MAGKSP	0.54	-0.11	-0.43	0.25	-0.11	-0.08	0.09	0.58
MAG1NN	0.58	-0.36	-0.15	0.05	0.17	0.20	0.21	0.60
MAGKDN	0.42	-0.23	-0.25	0.38	0.22	0.20	0.23	0.58
MAGJNB	0.64	-0.09	-0.07	0.17	0.18	0.20	0.08	0.53
MAGOSS	0.45	-0.02	-0.02	-0.59	0.00	0.30	-0.04	0.65
MAGRNT	0.59	0.03	0.23	0.40	-0.06	0.10	-0.38	0.72
MAGRNP	0.55	0.13	0.24	0.26	0.07	0.14	-0.32	0.57
MAGJUN	0.63	-0.02	-0.09	-0.07	0.26	0.29	-0.03	0.57
MAG360	0.66	-0.03	0.00	-0.13	0.22	0.22	-0.26	0.62
MAGOBR	0.68	-0.10	-0.18	0.17	-0.08	-0.39	-0.07	0.69
MAG4SM	0.68	-0.28	-0.09	0.05	-0.19	-0.28	0.03	0.67
MAGVAL	0.64	-0.24	0.15	-0.14	-0.20	-0.33	-0.19	0.69
MAGKON	0.54	-0.30	-0.13	0.14	-0.36	-0.28	0.09	0.63
MAGTUP	0.67	-0.23	-0.06	-0.43	-0.15	0.05	-0.06	0.72
MAGCRO	0.56	-0.07	0.15	0.25	0.03	0.20	-0.17	0.48
MAGOKK	0.74	0.18	-0.19	-0.08	-0.05	-0.15	-0.17	0.67
MAG20Y	0.64	0.45	-0.21	-0.18	-0.11	-0.09	-0.16	0.73
MAG4X5	0.68	0.30	-0.22	-0.36	-0.15	-0.05	-0.14	0.78
MAGHEX	0.42	0.03	0.56	0.08	-0.12	0.01	0.01	0.51
MAGPIV	0.61	0.07	0.39	0.11	0.12	0.07	-0.19	0.59
MAGSLA	0.44	0.34	-0.09	-0.22	0.46	-0.08	0.30	0.68
MAGTRI	0.45	-0.06	0.42	-0.31	0.16	-0.02	0.04	0.50
MAGBOX	0.49	0.26	0.15	0.13	0.48	-0.21	0.14	0.64
MAGSLO	0.57	0.48	-0.13	0.09	0.13	-0.20	0.00	0.64
MAGHX1	0.40	0.50	0.15	0.10	-0.38	0.31	0.31	0.78
MAGKRB	0.41	0.49	-0.07	0.04	0.19	-0.37	0.20	0.62
MAGTJS	0.34	0.13	0.37	-0.04	-0.27	-0.04	0.45	0.55
MAGO2S	0.43	-0.38	0.46	0.09	0.10	-0.16	0.19	0.62
MAGPOD	0.29	-0.51	0.52	-0.25	0.08	-0.13	0.17	0.72
MAGHX2	0.43	0.48	0.19	0.10	-0.44	0.31	0.22	0.79

MAGKUS - lateral steps, MAGNN2 - stride steps forward-backward, MAGKSP - lateral steps along the circle line, MAG1NN - single leg hops forward-backward, MAGKND - lateral steps over various distances, MAGJNB - single leg lateral hops, MAGOSS - figure of eight with ducking, MAGRNP - moving ahead with front turns of 180°(front pivot); MAGRNT - moving ahead with back turns of 180°(back pivot), MAGJNN - single leg hops forward-backward, hands free, MAG360 - running forward-backward with full turns, MAGOBR - moving inside a semicircle, MAG4SM - moving in four directions inside the circle, MAGVAL - running and rolling sideways, MAGKON - running with rolls backward, MAGTUP - running in a rectangle, MAGCRO - triple side-to-side with front-back turns, MAGOKK - basic basketball movements, MAG20Y - 20-yard shuttle test, MAG4X5 - 20-metre square, MAGHEX - hexagon test, MAGPIV - run and pivot, MAGSLA - slalom (zigzag) run, MAGTRI - running forward along the three-point line, MAGBOX - simulating "boxing attack and retreat", MAGSLO - slalom with back pivots, MAGHX1 - single leg hexagon, MAGKRB - lateral movement (side shuffle) along the circle line with the back to the centre of the basketball court, MAGTJS - single leg hops in three directions, MAGO2S - single leg hops around the boxes, MAGPOD - slipping under a ribbon immitating punch-avoiding moves, MAGHX2 - double leg hexagon

and the corresponding orthoblique factors are in the lower part of it[2].

A comparison of parallel and orthogonal projections of the comparable promax and orthoblique factors (Tables 3 and 4) reveals a great similarity of the obtained solutions, which can be confirmed by the strong correlations (above 0.99) among these factors (Table 6). It means that dimen-

[2] Certain orthoblique factors (the third and the seventh) are reverse-scaled in the factor space because of the transformational algorithm, which is also manifested in the negative direction of relations with the rest of the orthoblique factors. The insignificance of the phenomenon is corroborated by the promax solution where these factors are normally scaled.

sions with practically an identical latent base were obtained in both factor analyses. (Table 3)

Table 3. Pattern of the promax (P) and orthoblique (O) factors

	P1	O6	P2	O1	P3	O7	P4	O5	P5	O4	P6	O3	P7	O2
MAGKUS	0.21	0.15	0.66	0.69	-0.21	0.24	-0.05	-0.07	0.21	0.20	-0.06	0.06	0.04	0.04
MAGNN	0.36	0.31	0.50	0.50	-0.02	0.04	-0.26	-0.27	0.32	0.32	-0.03	0.04	0.04	0.03
MAGKSP	0.53	0.54	0.43	0.41	-0.02	0.03	0.08	0.04	-0.15	-0.14	-0.22	0.25	0.03	0.04
MAG1NN	0.08	-0.01	0.64	0.67	0.00	0.03	0.03	0.04	0.13	0.12	0.17	-0.18	0.00	-0.01
MAGKDN	0.04	-0.03	0.75	0.80	0.12	-0.09	0.12	0.12	-0.27	-0.30	-0.05	0.03	0.03	0.02
MAGJNB	0.00	-0.06	0.49	0.51	0.28	-0.26	0.13	0.15	0.04	0.03	0.04	-0.03	0.05	0.04
MAGOSS	-0.23	-0.28	0.05	0.04	-0.13	0.13	-0.11	-0.08	0.94	0.95	0.12	-0.09	0.07	0.06
MAGRNT	0.16	0.15	-0.01	-0.03	0.92	-0.92	-0.18	-0.16	-0.17	-0.16	-0.06	0.08	0.03	0.03
MAGRNP	-0.05	-0.06	-0.02	-0.03	0.81	-0.81	-0.03	0.00	-0.03	-0.02	-0.03	0.06	0.02	0.02
MAGJUN	-0.21	-0.28	0.39	0.41	0.26	-0.26	0.13	0.16	0.38	0.38	-0.01	0.02	-0.03	-0.04
MAG360	-0.14	-0.20	0.16	0.16	0.45	-0.46	0.02	0.05	0.49	0.51	0.01	0.03	-0.16	-0.17
MAGOBR	0.74	0.77	0.07	0.01	0.10	-0.12	0.24	0.19	-0.15	-0.12	0.03	0.04	-0.15	-0.15
MAG4SM	0.72	0.73	0.14	0.09	-0.01	0.02	0.02	-0.02	0.00	0.02	0.20	-0.15	-0.03	-0.03
MAGVAL	0.65	0.66	-0.21	-0.29	0.15	-0.16	-0.06	-0.08	0.21	0.25	0.33	-0.26	-0.14	-0.15
MAGKON	0.82	0.85	0.16	0.10	-0.08	0.11	-0.12	-0.17	-0.14	-0.13	0.13	-0.10	0.09	0.09
MAGTUP	0.28	0.24	0.07	0.03	-0.09	0.10	-0.16	-0.17	0.72	0.74	0.20	-0.16	-0.01	-0.02
MAGCRO	0.02	-0.02	0.20	0.21	0.63	-0.61	-0.13	-0.10	-0.02	-0.02	0.04	-0.03	0.05	0.05
MAGOKK	0.38	0.41	-0.03	-0.09	0.17	-0.19	0.24	0.21	0.29	0.33	-0.13	0.21	-0.04	-0.04
MAG20Y	0.22	0.28	-0.18	-0.25	0.10	-0.13	0.30	0.27	0.41	0.45	-0.27	0.36	0.11	0.12
MAG4X5	0.25	0.29	-0.14	-0.21	-0.04	0.02	0.18	0.15	0.64	0.68	-0.17	0.25	0.09	0.09
MAGHEX	0.05	0.04	-0.16	-0.19	0.40	-0.38	-0.03	-0.01	-0.04	-0.06	0.43	-0.42	0.28	0.28
MAGPIV	-0.06	-0.09	-0.05	-0.07	0.65	-0.66	0.08	0.11	0.07	0.07	0.24	-0.21	0.04	0.03
MAGSLA	-0.23	-0.25	0.19	0.18	-0.30	0.28	0.84	0.84	0.23	0.23	0.12	-0.07	-0.01	-0.02
MAGTRI	-0.10	-0.15	-0.11	-0.14	0.08	-0.08	0.18	0.21	0.39	0.38	0.52	-0.50	0.01	-0.01
MAGBOX	-0.08	-0.09	0.10	0.09	0.15	-0.18	0.79	0.80	-0.20	-0.20	0.22	-0.18	-0.10	-0.11
MAGSLO	0.17	0.22	-0.03	-0.08	0.12	-0.15	0.63	0.60	-0.04	-0.01	-0.17	0.24	0.06	0.07
MAGHX	-0.12	-0.07	0.09	0.07	0.07	-0.02	0.03	0.02	0.06	0.02	-0.09	0.08	0.85	0.88
MAGKRB	0.18	0.25	-0.08	-0.14	-0.17	0.13	0.84	0.79	-0.16	-0.15	0.00	0.07	0.07	0.07
MAGTJS	0.14	0.16	0.00	-0.04	-0.22	0.27	0.16	0.14	-0.04	-0.09	0.43	-0.43	0.60	0.61
MAGO2S	0.24	0.18	0.13	0.12	0.13	-0.11	0.09	0.11	-0.19	-0.21	0.67	-0.68	0.00	-0.02
MAGPOD	0.13	0.06	-0.01	-0.02	-0.08	0.11	-0.06	-0.02	0.17	0.15	0.82	-0.83	-0.08	-0.11
MAGHX2	-0.08	-0.03	0.02	-0.01	0.17	-0.11	-0.07	-0.08	0.10	0.07	-0.09	0.09	0.83	0.86

MAGKUS - lateral steps, MAGNN2 - stride steps forward-backward, MAGKSP - lateral steps along the circle line, MAG1NN - single leg hops forward-backward, MAGKND - lateral steps over various distances, MAGJNB - single leg lateral hops, MAGOSS - figure of eight with ducking, MAGRNP - moving ahead with front turns of 180°(front pivot); MAGRNT - moving ahead with back turns of 180°(back pivot), MAGJNN - single leg hops forward-backward, hands free, MAG360 - running forward-backward with full turns, MAGOBR - moving inside a semicircle, MAG4SM - moving in four directions inside the circle, MAGVAL - running and rolling sideways, MAGKON - running with rolls backward, MAGTUP - running in a rectangle, MAGCRO - triple side-to-side with front-back turns, MAGOKK - basic basketball movements, MAG20Y - 20-yard shuttle test, MAG4X5 - 20-metre square, MAGHEX - hexagon test, MAGPIV - run and pivot, MAGSLA - slalom (zigzag) run, MAGTRI - running forward along the three-point line, MAGBOX - simulating "boxing attack and retreat", MAGSLO - slalom with back pivots, MAGHX1 - single leg hexagon, MAGKRB - lateral movement (side shuffle) along the circle line with the back to the centre of the basketball court, MAGTJS - single leg hops in three directions, MAGO2S - single leg hops around the boxes, MAGPOD - slipping under a ribbon immitating punch-avoiding moves, MAGHX2 - double leg hexagon

Even superficial inspection of the matrices reveals that the applied methods of factor analysis produced conspicuously simple solutions where a large number of tests defined the first five dimensions. Their relatively high and equal parallel and orthogonal projections indicate the pronounced

homogeneity of the groups of variables. The last two dimensions are typical dualfactors probably produced by the high partial correlations between the two pairs of variables. This also must be the reason for their insignificant or low relations with the first five factors. It refers to the sixth promax and the third orthoblique dual factors in particular, which, in fact, do not actually pertain to the analyzed space. (Table 4)

Table 4. Structure of the promax (P) and orthoblique (O) factors

	P1	O6	P2	O1	P3	O7	P4	O5	P5	O4	P6	O3	P7	O2
MAGKUS	0.44	0.47	0.72	0.74	0.18	-0.19	0.16	0.17	0.42	0.44	0.01	-0.07	0.07	0.10
MAGNN	0.60	0.62	0.67	0.72	0.34	-0.36	0.13	0.13	0.55	0.58	0.08	-0.16	0.12	0.16
MAGKSP	0.62	0.63	0.54	0.59	0.30	-0.31	0.30	0.29	0.29	0.31	-0.16	0.09	0.16	0.17
MAG1NN	0.38	0.44	0.74	0.75	0.35	-0.37	0.23	0.26	0.41	0.45	0.26	-0.31	0.06	0.11
MAGKDN	0.26	0.32	0.72	0.72	0.30	-0.31	0.22	0.24	0.12	0.15	0.05	-0.08	0.05	0.09
MAGJNB	0.38	0.44	0.62	0.65	0.54	-0.55	0.40	0.42	0.42	0.44	0.15	-0.20	0.19	0.25
MAGOSS	0.19	0.20	0.24	0.27	0.23	-0.22	0.21	0.21	0.75	0.75	0.15	-0.20	0.16	0.21
MAGRNT	0.44	0.45	0.24	0.30	0.81	-0.82	0.28	0.27	0.28	0.29	0.11	-0.18	0.26	0.31
MAGRNP	0.31	0.33	0.21	0.26	0.75	-0.75	0.36	0.35	0.33	0.33	0.11	-0.16	0.25	0.30
MAGJUN	0.29	0.34	0.56	0.58	0.53	-0.53	0.43	0.44	0.59	0.60	0.10	-0.15	0.14	0.21
MAG360	0.35	0.38	0.42	0.47	0.63	-0.63	0.40	0.40	0.66	0.65	0.13	-0.19	0.08	0.15
MAGOBR	0.78	0.80	0.36	0.44	0.48	-0.49	0.46	0.45	0.38	0.41	0.06	-0.14	0.11	0.14
MAG4SM	0.78	0.80	0.42	0.50	0.42	-0.44	0.30	0.30	0.43	0.47	0.24	-0.32	0.16	0.18
MAGVAL	0.71	0.71	0.16	0.25	0.48	-0.50	0.26	0.26	0.51	0.54	0.36	-0.44	0.10	0.12
MAGKON	0.75	0.75	0.36	0.43	0.28	-0.30	0.13	0.13	0.27	0.31	0.16	-0.24	0.20	0.20
MAGTUP	0.57	0.59	0.37	0.44	0.37	-0.38	0.23	0.24	0.78	0.80	0.25	-0.34	0.15	0.19
MAGCRO	0.34	0.38	0.39	0.43	0.65	-0.66	0.25	0.25	0.32	0.35	0.18	-0.24	0.21	0.26
MAGOKK	0.67	0.67	0.28	0.37	0.57	-0.56	0.59	0.57	0.65	0.65	-0.09	0.00	0.26	0.30
MAG20Y	0.55	0.53	0.09	0.18	0.49	-0.46	0.64	0.60	0.66	0.64	-0.26	0.18	0.40	0.43
MAG4X5	0.60	0.58	0.16	0.25	0.44	-0.42	0.56	0.53	0.80	0.78	-0.16	0.07	0.35	0.39
MAGHEX	0.24	0.27	0.03	0.06	0.50	-0.51	0.21	0.23	0.20	0.24	0.47	-0.51	0.39	0.42
MAGPIV	0.31	0.35	0.20	0.25	0.73	-0.73	0.41	0.42	0.39	0.42	0.34	-0.39	0.27	0.32
MAGSLA	0.13	0.18	0.27	0.28	0.21	-0.19	0.73	0.75	0.42	0.42	0.05	-0.06	0.16	0.20
MAGTRI	0.18	0.22	0.11	0.14	0.37	-0.38	0.31	0.34	0.45	0.47	0.53	-0.55	0.15	0.19
MAGBOX	0.20	0.27	0.24	0.26	0.47	-0.45	0.73	0.74	0.23	0.24	0.21	-0.22	0.14	0.18
MAGSLO	0.44	0.45	0.15	0.22	0.49	-0.46	0.76	0.74	0.40	0.39	-0.18	0.13	0.34	0.38
MAGHX	0.21	0.21	0.09	0.13	0.34	-0.34	0.35	0.34	0.28	0.28	-0.08	0.03	0.87	0.88
MAGKRB	0.32	0.35	0.03	0.08	0.27	-0.25	0.75	0.74	0.23	0.23	-0.09	0.06	0.30	0.31
MAGTJS	0.24	0.27	0.05	0.08	0.17	-0.18	0.25	0.27	0.16	0.19	0.38	-0.41	0.60	0.59
MAGO2S	0.30	0.37	0.30	0.31	0.36	-0.39	0.15	0.20	0.12	0.18	0.71	-0.73	0.08	0.10
MAGPOD	0.17	0.22	0.17	0.17	0.15	-0.19	-0.03	0.02	0.20	0.25	0.82	-0.83	-0.06	-0.05
MAGHX2	0.25	0.24	0.06	0.11	0.40	-0.39	0.31	0.30	0.31	0.31	-0.06	0.00	0.87	0.88

MAGKUS - lateral steps, MAGNN2 - stride steps forward-backward, MAGKSP - lateral steps along the circle line, MAG1NN - single leg hops forward-backward, MAGKND - lateral steps over various distances, MAGJNB - single leg lateral hops, MAGOSS - figure of eight with ducking, MAGRNP - moving ahead with front turns of 180°(front pivot); MAGRNT - moving ahead with back turns of 180°(back pivot), MAGJNN - single leg hops forward-backward, hands free, MAG360 - running forward-backward with full turns, MAGOBR - moving inside a semicircle, MAG4SM - moving in four directions inside the circle, MAGVAL - running and rolling sideways, MAGKON - running with rolls backward, MAGTUP - running in a rectangle, MAGCRO - triple side-to-side with front-back turns, MAGOKK - basic basketball movements, MAG20Y - 20-yard shuttle test, MAG4X5 - 20-metre square, MAGHEX - hexagon test, MAGPIV - run and pivot, MAGSLA - slalom (zigzag) run, MAGTRI - running forward along the three-point line, MAGBOX - simulating "boxing attack and retreat", MAGSLO - slalom with back pivots, MAGHX1 - single leg hexagon, MAGKRB - lateral movement (side shuffle) along the circle line with the back to the centre of the basketball court, MAGTJS - single leg hops in three directions, MAGO2S - single leg hops around the boxes, MAGPOD - slipping under a ribbon immitating punch-avoiding moves, MAGHX2 - double leg hexagon

The first promax and the comparable sixth orthoblique factor have mutual correlation of 0.992. This allows us to say that these two factors carry a great portion of identical information about the latent structure of the investigated space. The variables best describing the factor (within both systems) are: *moving inside a semicircle* - MAGOBR, *moving in four directions inside the circle* - MAG4SM, *running and rolling sideways* - MAGVAL and *running with rolls backward* - MAGKON.

The structure of the tests with the largest projections on the factor is extremely complex. The basic characteristic of all the tests, though, is the performance of a large number of various types of movements in different planes and directions within a limited (small) space of a circular shape, including the following basic movements: side, front and back rolls, standing-up, forward movements and back pedal, semicircular and straight lateral shuffle movements and semicircular frontal movements. Further, enormous demands on different attributes of balance are also present in all the mentioned tests. It is particularly true for tests *running and rolling sideways* - MAGVAL and *running with rolls backward* - MAGKON in which the subjects are expected to stand up after the completion of the rotation movements (rolls sideways and backwards) on the floor and to procede with semicircular frontal movements.

In the tests describing this latent dimension special demands are reflected in the performance of multiple and multi-direction changes of movement direction in the short time sequences. When these conditions are associated with the demands to perform the tasks in a relatively small space, it is easy to conclude that we are dealing here with a latent dimension of an extremely high complexity in which a high level of balance is a crucial precondition for a successful task performance.

This factor can be named as AGILITY IN MULTIPLE CHANGES OF MOVEMENT DIRECTIONS IN A SMALL SPACE. The factor has established the highest correlations with P5/O4, P3/O7, P4/O5 and P2/O1.

The second promax and, comparable to it, the first orthoblique factor are interrelated with a correlation of 0.991 (Table 6). So it can be said they carry similar information about the latent base. The matrices of pattern and structure show that the same group of agility tests define this factor: *lateral steps* - MAGKUS, *stride steps forward-backward* - MAGNN2, *lateral steps along the circle line* - MAGKSP, *single leg hops forward-backward* - MAG1NN and MAGKDN.

Generally, movement structures in the listed tests contain direction changes in frontal and lateral movements. The movements are performed over short distances (2 and 4 metres), and the types of movements include: running forward, back pedal, lateral movements – side steps and shuffle steps, as well as frontal and lateral single leg hops.

The tests demand a quick performance of circular movements, effective stops and quick cuts (direction changes). We can assume that a crucial precondition for a successful performance is the ability to activate and relax quickly the appropriate muscle groups, and the elastic (plyometric) quality of the lower extremities.

The crucial detail of performance in these tests focuses on the way of decelerating (stopping) and on quick cuts, i.e. on the transition into a new direction of movement, no matter of which type. The motor skills of decelerating and re-starting and of cutting include numerous variable biomechanical parameters which determine the speed and quality of performance. The most important among them are body posture, i.e. the position of the centre of gravity, weight distribution on particular parts of the feet and the way of planting the feet in the positions most appropriate for the intended change of direction.

Therefore, the promax 2 / orthoblique 1 factor can be named as AGILITY IN SIMPLE FRONTAL AND LATERAL MOVEMENTS.

The biggest relations were registered between this factor and the P5/O4, P1/O6 and P3/O7 factors.

Table 5. Correlations among the promax (P) factors (above the diagonal) and the orthoblique (O) factors (beneath the diagonal)

	P1	P2	P3	P4	P5	P6	P7
O6	**1.00**	0.35	0.47	0.37	0.52	0.03	0.26
O1	0.53	**1.00**	0.32	0.19	0.36	0.13	0.01
O7	-0.52	-0.41	**1.00**	0.52	0.49	0.18	0.32
O5	0.41	0.28	-0.48	**1.00**	0.47	-0.05	0.32
O4	0.56	0.45	-0.5	0.46	**1.00**	0.05	0.24
O3	-0.22	-0.18	0.3	-0.06	-0.21	**1.00**	-0.01
O2	0.27	0.12	-0.39	0.37	0.31	-0.06	**1.00**

The third promax and the comparable seventh orthoblique factor are interrelated with the correlation of 0.998, so it could be considered that they contain almost identical information about a homogenous latent base. The same group of agility tests (*moving ahead with back half turns (back pivot)* - MAGRNT, *moving ahead with front half turns (front pivot)* - MAGRNP, *triple side-*

to-side with front-back turns - MAGCRO, *run and pivot* - MAGPIV, *running forward-backward with full turns* - MAG360) defines both the pattern and the structure of the comparable factors. Speed of multiple, consecutive coverings of the determined short distances in these tests depends highly on effective performance and linking of a certain type of movement with turns around the longitudinal body axis. We are dealing here with diverse variations of twist movements (turns around the longitudinal body axis) in either a dynamic or stationary straight-up body position, which were derived from the actual technical elements of combat sports (taekwondo, karate) and some sport games (basketball, handball). Since various types of straight-up rotations is a major manifest characteristic of the factor, this factor is named AGILITY IN TWIST MOVEMENTS. This dimension of agility has established statistically significant correlations with all the isolated factors, especially with the first, fourth and fifth promax factors (and with the corresponding sixth, fifth and fourth orthobliqe factors). It indicates that the variability of this specific dimension is under probable considerable influence of general agility. Further, twists and their linkage cannot be, by any means, classified as natural movement structure patterns. Therefore, it is feasible to conclude that other motor abilities also have a certain influence on the variability of this dimension. The motor knowledge transfer must not be excluded either from the group of factors having a strong influence on the variability of this interesting dimension.

Table 6. Correlations among the promax and orthoblique factors

	O1	O2	O3	O4	O5	O6	O7
P1	0.460	0.267	-0.158	0.539	0.349	**0.992**	-0.486
P2	**0.991**	0.064	-0.186	0.382	0.227	0.424	-0.339
P3	0.397	0.385	-0.269	0.502	0.502	0.501	**-0.998**
P4	0.253	0.370	0.000	0.453	**0.996**	0.410	-0.488
P5	0.416	0.300	-0.157	**0.996**	0.453	0.514	-0.478
P6	0.113	0.000	**-0.990**	0.130	0.027	0.113	-0.217
P7	0.061	**0.995**	-0.045	0.246	0.311	0.253	-0.312

The fourth isolated promax and the comparable fifth orthoblique factor are best defined by the following four agility tests: *slalom run* - MAGSLA, *simulating boxing attack and retreat* - MAGBOX, *slalom with back pivots* - MAGSLO, *lateral movement along the circle line* - MAGKRB. Parallel projections of these variables on the factor range between 0.63 and 0.84, and between 0.60 and 0.84 in the promax and orthoblique solution, respectively (Table 3). The correlations of the tests with the mentioned factor are very homogeneous and quote between 0.73 and 0.76, and between 0.74 and 0.75 in the promax and orthoblique solution, respectively (Table 4). However, it is difficult to determine the similarities in movement structure patterns of the listed tests – two tests comprise various ways of turning round the stands/cones with the direction changes of up to 90°, one test demands direction changes in a small space, and one consists of lateral movements along the circle line with the back to the centre. If we, however, consider the movements along the circle line as movements along a symmetrical polygon, then we can extract the fact that all four tests contain movements with changes of direction of up to 90°. This factor is therefore interpreted as AGILITY IN FRONTAL AND LATERAL MOVEMENTS WITH CHANGES OF DIRECTION OF UP TO 90°. This factor establishes the highest correlations with the agility factor in frontal movements with changes of direction over 90° (promax 5/orthoblique 4), which also corroborates the existence of the described dimension.

The fifth promax and the fourth orthoblique factors are, according to pattern and structure, very similar dimensions, which is corroborated by a high correlation of 0.996 (Table 6). In both oblique solutions this factor is primarily determined by the tests: *figure of eight with ducking* - MAGOSS, *running in a rectangle* - MAGTUP and *20-metre square* - MAG4x5. This group of motor activities shares several common characteristics:

- Acceleration before cuts is performed in the most natural way, i.e. facing forward;
- Accelerations are performed over distances of 4-5 metres which allows the body mass to gain considerable movement inertia;
- Cuts (changes of movement direction) of 90° to 360° are performed circularly around stands/cones.

It seems as if this dimension of agility integrates several different motor abilities. Probably, it is not free from the influence of certain motor (skills) knowledge. Namely, speed of covering short distances of 4-5m most certainly depends to a great extent on the starting acceleration (starting quickness), which is based, primarily, on explosive power, but on the specific skill of starting as well. The subsequent phase of movement is determined by the precise timing in deceleration to the speed being optimal for starting and the performance of cuts. Turning around stands/cones on a semicircular or circular path, while simultaneously maintaining the highest possible speed of movement, requires

special motor knowledge, i.e. a movement technique that provides efficacious control over the dynamic movement of the body mass under the conditions of strong centrifugal forces. Some of the described phases of movement are also present in a number of the other agility tests, therefore, the 15 agility tests have established significant correlations with that dimension, ranging from 0.44 to 0.66. This is also a reason for the relatively high correlations (0.45 - 0.56) of this agility factor with a lot of other dimesions. This factor can be termed AGILITY IN FRONTAL MOVEMENTS WITH CHANGES OF DIRECTION ABOVE 90°.

The sixth promax and the third orthoblique factors are almost identical by their pattern and structure. This latent dimension is defined by only two tests (*slipping under a ribbon by punch-avoiding movements* - MAGPOD and *single leg hops around the boxes* - MAGO2S). Their parallel and orthogonal projections are markedly high in relation to the rest of the tests. This, in fact, dual factor has the lowest relations to the rest of the isolated factors. Therefore, it can be considered that this linear combination carries information irrelevant to the space of agility, so this factor is neither analysed nor nominated.

Something similar happened, although to a lesser extent, to the last isolated dimension, i.e. to the seventh promax and, almost identical, the second orthoblique factor. This factor is, in fact, predominantly determined by two tests that are different modifications of the popular hexagon-test. Since the original test has larger, although not very high, projections on the other factors, and because it has no significant projections on the factor determined by the two derived test modifications, it seems as if these two test derivations share a portion of variance which is specific just to them. Due to the lack of information, this factor will not be defined separately either. Low interpretability of the last two dimensions may be explained by a fact that this part of the agility space was not properly covered with measurement instruments.

Conclusion

The aim of the research was to analyse the structure of latent dimensions that are in the background of variability and covariability of the motor tests aimed at assessing agility. The 32-test battery was designed for the sake of this research. It included practically most tests ever used in investigations of motor phenomena and/or in sports training practice, but it also embraced several original tests that had been created for the purpose of this research project. The experiment was conducted with the participant sample of the 152 freshmen from the Faculty of Kinesiology in Zagreb, Croatia.

On the basis of the obtained results, a matrix of corrrelations was computed and then subjected to the exploratory component factor analysis. The first principal component exhausts a little bit more than 30% of the total variability, but it is simultaneously responsible for almost 50% of the information issued by the the total of the first seven principal components, being significant according to the applied PB-criterion. It is feasible to conclude with considerable certainty that a factor of general or fundamental agility exists in the space of the selected tests. However, the structure of the first principal component reveals that the general factor of agility does not affect equally the variability of all the tests in the presented constellation of variables. In most of the chosen motor tasks the influence of the fundamental agility is relatively high, whereas it is relatively low in several tests, meaning that the sample of variables did not cover the space of agility evenly.

The seven significant principal components were transformed into two oblique parsimonic solutions by means of promax and orthoblique factor solutions. Both analyses resulted in numerically simple and very similar solutions, which enhanced the reliability of the isolated latent dimensions. Due to obvious similarity, the comparative factors from both solutions were interpreted simultaneously with respect to the sequence of the factors obtained in the promax solution. Out of the seven isolated factors, only the first five were interpretable. Their interrelations in both factor analyses clearly indicate to the conclusion that the general factor of agility exists in the space of the higher order. The sixth and the seventh factors are, in fact, dual factors, which were not interpreted because of a lack of valid information. The isolated latent dimensions are named according to the mentioned sequence as follows:

I. AGILITY IN MULTIPLE CHANGES OF MOVEMENT DIRECTIONS IN A SMALL SPACE;
II. AGILITY IN SIMPLE FRONTAL AND LATERAL MOVEMENTS;
III. AGILITY IN TWIST MOVEMENTS;
IV. AGILITY IN FRONTAL AND LATERAL MOVEMENTS WITH CHANGES OF DIRECTION OF UP TO 90°;
V. AGILITY IN FRONTAL MOVEMENTS WITH CHANGES OF DIRECTION ABOVE 90°.

The study reveals that the space of agility is far more complex than it is commonly regarded among experts in the area of motor phenomena, i.e. kinesiologists or sport scientists. Therefore, the space of agility should be further and more profoundly investigated. The anticipated findings may be very useful not only to researchers in the area of general motor abilities, but to the researchers and practitioners in all disciplines of applied kinesiology as well, especially those in which agility is an important component of performance and sport achievements. The future will surely bring advances in the technology of measuring the manifested abilities (new tests and measuring procedures), as well as new basic biomedical concepts of and insights into human motor behaviour. The authors themselves will continue to investigate the space of agility.

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LATENTNA STRUKTURA TESTOVA AGILNOSTI

Sažetak

Uvod

Većina polistrukturnih i kompleksnih sportova u svojoj strukturi sadrži promjene smjera kretanja. Sposobnost koja se najizraženije manifestira u takvim uvjetima naziva se agilnost (grč. *agilis* – okretan, vrijedan, brz, žustar). Stoga se za potrebe sporta, a osobito kondicijske pripreme, agilnost može definirati kao sposobnost brzog i učinkovitog premještanja tijela u prostoru u uvjetima naglog zaustavljanja i promjena pravca kretanja. Pozicija agilnosti u općem motoričkom prostoru do sada se različito razmatrala. Gredelj i suradnici (1975) agilnost svrstavaju među sposobnosti koje su podređene mehanizmu za strukturiranje gibanja, u okviru kojega su još i koordinacijske sposobnosti te brzina alternativnih pokreta. Bompa (1999) tretira agilnost kao kombinaciju temeljnih sposobnosti brzine i koordinacije. U novije vrijeme se u literaturi koja obrađuje probleme kondicijske pripreme (Pearson, 2001; Graham, 2000), agilnost može pronaći uronjena u kontekst zajedno sa sposobnostima brzine i eksplozivnosti (*speed, agility and quickness* – SAQ). Verstegen i Marcello (2001) također u bliski strukturni i trenažni odnos stavljaju agilnost i koordinaciju, nazivajući te dvije sposobnosti temeljima graciozne, skladne sportske izvedbe. Isti autori objašnjavaju agilnost kao sposobnost koja sportašu dopušta kretanje u željenom pravcu, čini ga spremnim za promjenu smjera i brzo zaustavljanje te sposobnim za izvedbu brzih, tečnih, učinkovitih i ponavljajućih pokreta.

U ovom istraživanju, koje je u biti preliminarnoga karaktera, autori su pokušali odgovoriti na neke dileme vezane za strukturu prostora agilnosti. Stoga je i osnovni cilj ovog istraživanja bilo utvrđivanje latentne strukture većeg broja motoričkih testova namijenjenih procjeni agilnosti.

Metode istraživanja

Uzorak ispitanika. Istraživanje je provedeno na uzorku od 152 studenta prve godine Kineziološkog fakulteta Sveučilišta u Zagrebu. Prema tome, uzorak ispitanika je izvučen iz populacije kineziološki aktivnih mladih osoba muškog spola, koji se sigurno mogu smatrati pozitivno selekcioniranima s obzirom na funkcionalne i motoričke sposobnosti te morfološke karakteristike. Stoga se i rezultati ovog istraživanja mogu u najvećoj mjeri primijeniti na populaciju sličnih obilježja.

Uzorak varijabli. Za potrebe ovog istraživanja oblikovan je sklop od 32 motorička testa namijenjena procjeni agilnosti. U svim primijenjenim testovima rezultati su izraženi vremenom potrebnim za uspješno izvođenje određenog motoričkog zadatka.

Metode obrade razultata. U svakom od 32 motorička testa agilnosti provedena su tri uzastopna mjerenja, a konačni rezultati u svakom pojedinačnom testu dobiveni su kondenzacijom rezultata na prvu glavnu komponentu internih matrica interkorelacija čestica. Zatim je izračunata matrica interkorelacija između testova agilnosti koja je podvrgnuta eksplorativnom postupku faktorske analize. Za tu svrhu izračunate su varijance glavnih komponenata te njihovi parcijalni i kumulativni doprinosi ukupnom varijabilitetu analiziranog prostora. Broj značajnih faktora određen je PB-kriterijem (Štalec i Momirović, 1971), a zatim je izračunata matrica korelacija testova agilnosti sa značajnim glavnim osovinama, kao i komunalitet svakoga testa. Ortogonalni sustav značajnih glavnih komponenata transformiran je u dvije različite kosokutne solucije *(orthoblique i promax)* i to uz Kaiserov postupak normalizacije. Konačni rezultati primijenjenih faktorskih analiza predstavljeni su u matricama sklopa i strukture *promax* i *orthoblique* faktora te u matricama korelacija između faktora dobivenih jednom i drugom solucijom. Na kraju su izračunate kongruencije između *promax* i *orthoblique* faktora radi potpunijeg uvida u strukturu i stabilnost latentnih dimenzija analiziranog prostora.

Rezultati i rasprava

Faktorizacijom matrice interkorelacija testova za procjenu agilnosti ekstrahirano je sedam značajnih glavnih komponenata. Te komponente su zatim transformirane u dvije kosokutne parsimonijske solucije primjenom *promax* i *orthoblique* faktorskih rješenja. Obje analize polučile su numerički jednostavne i vrlo slične solucije, što dodatno povećava vjerodostojnost izoliranih latentnih dimenzija. Od sedam izoliranih faktora, samo prvih pet je bilo moguće logički interpretirati. Njihove međusobne relacije u obje faktorske analize jasno upućuju na zak-

ljučak o egzistenciji generalnog faktora agilnosti u prostoru višeg reda. Šesti i sedmi faktor predstavljaju u stvari dualne faktore koji zbog nedostatka valjanih informacija nisu interpretirani. Izolirane latentne dimenzije imenovane su na sljedeći način:

I. Agilnost u izvođenju različitih promjena pravca kretanja na malom prostoru;
II. Agilnost u uvjetima jednostavnih frontalnih i lateralnih kretanja;
III. Agilnost u rotacijskim gibanjima;
IV. Agilnost u frontalnim i lateralnim kretanjima s promjenama smjera do 90°;
V. Agilnost u frontalnom kretanju s promjenama smjera većima od 90°.

Zaključak

Eksperiment je pokazao kako je prostor agilnosti znatno složeniji no što to obično stručnjaci za područje motoričkih fenomena najčešće misle. Zbog toga se ovaj prostor treba detaljnije istražiti jer dobivene spoznaje mogle biti bi korisne kako za područje općih motoričkih sposobnosti, tako i za sve primijenjene kineziološke discipline gdje je agilnost važna komponenta sportske uspješnosti. Novije vrijeme će zasigurno donijeti nove mogućnosti u tehnologiji testiranja manifestnih varijabli (izbor testova i postupak mjerenja), ali i u povećanju bazičnih antropoloških spoznaja o motoričkom ponašanju čovjeka.