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EVALUATING THE COORDINATION OF MOTOR ABILITIES IN GRECO-ROMAN WRESTLERS BY COMPUTER TESTING

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DARIUSZ GIERCZUK [1]*, WŁODZIMIERZ LJACH [1, 2]

[1] Józef Piłsudski University of Physical Education, Warszawa, Faculty of Physical Education, Biała Podlaska, Poland
[2] University School of Physical Education, Kraków, Poland

ABSTRACT
Purpose. The aim of this study was to evaluate, by using a number of selected criteria, the accuracy of Vienna Test System (VST) computer tests used in wrestling to evaluate motor skill development. **Methods.** Fifteen 16–17-year-old students from the SMS Sports School in Radom, Poland, who had been practising Greco-Roman wrestling for a period of 3 to 6 years took part in a VTS-based examination that measured coordination of motor abilities (CMA). Test reliability and validity were evaluated on the basis of thirty test scores characterising six abilities that define motor coordination. Reliability was defined by performing the tests twice (test/retest) over a period of three-to-five days. The validity of the selected scores was established with the help of three different criteria. **Results.** Thirteen out of the thirty CMA scores under investigation demonstrated sufficient coefficients of reliability. The CMA tests assessing quick reaction time, frequency of movements, partial spatial orientation, movement adaptability and movement coupling fulfilled the assumed criterion. In most cases, the coefficients of validity were not lower than 0.3. The highest validity level was demonstrated by scores measuring movement coupling, complex reaction time, spatial orientation and movement adaptability, while the lowest one was found in simple reactions and frequency of movements. **Conclusions.** The obtained reliability and validity coefficients of the scores based on complex reaction, partial spatial orientation, movement adaptability and movement coupling confirm the usefulness of these specific tests in diagnosing CMA in wrestlers, as they meet the demands of sports metrology.

Key words: wrestling, computer tests, reliability and validity tests

Introduction

Monitoring the coordination of motor abilities (CMA) plays a substantial role in managing the training process of wrestlers. This includes measuring CMA development and, if found insufficient, allows for opportunities to introduce corrective measures in later training sessions. Thus, CMA measurements provide an excellent management tool for monitoring the complex movements that are featured in wrestling [1–5]. One of the best ways to monitor wrestlers' technical competency and preparation levels is by having them participate in competitions. However, evaluation tests performed during training sessions, whether by a coach or in a laboratory, may be a far quicker and more convenient alternative.

An analysis of national and international literature indicates that there is a wide range of tests that are applicable for diagnosing CMA levels in wrestlers [2, 4–6]. The ones that have been used the most frequently are motor skill tests that test either general and specific CMA [2–6]. Unfortunately, the plethora of different CMA measurement methods used in wrestling creates some difficulties when attempting to compare results, such as when attempting to define predominant CMA [2, 3, 5]. Furthermore, the bulk of the tests currently used to evaluate CMA can be influenced by various factors, e.g. physical conditioning or execution technique, and this can provide distorted results and a less accurate picture of an individual's coordination of motor abilities [7].

An alternative to the miscellaneous research tools mentioned above are computer tests, which are praised for their high precision and reliability [7–13]. The use of such instrumental methods in sport enables researchers to better quantify movement coordination. These include, inter alia, tests that are part of the Vienna Test System (VTS, Schuhfried GmbH, Austria). These tests are designed to diagnose a wide range of motor and neuropsychical abilities as well as neurophysiological predispositions that condition the processes of motor control [13–16]. Thanks to specially selected computer tests, it is possible to precisely determine an athlete's CMA development. However, a perusal of the available literature on combat sports and wrestling finds no mention of measuring CMA by computer tests, such as the VTS.

Therefore, this study sought to assess the accuracy of VTS-based computer tests that could be used to measure the levels of CMA in wrestlers. This study attempted to address the following research questions:

1. What is the index of reliability and validity of computer tests used to assess CMA in wrestlers?
2. How can such computer tests be utilised in the training process of wrestlers?

* Corresponding author.

Material and methods

Fifteen male adolescents that practise Greco-Roman wrestling at the Sports School in Radom, Poland took part in the study. The subjects were aged 16÷17 years (16.5 ± 0.52 y) who had been practicing wrestling for 3 to 6 years (4.1 ± 0.88 y). Ten wrestlers were qualified as being in the so-called first sports class, whereas the remaining were in the second sports class. All the wrestlers volunteered to participate in the experiment and provided their consent; the subjects were motivated by having their competencies analysed and an assessment provided of their psychomotor abilities.

Research was carried out at the beginning of the preseason at a sports camp in Giżycko, Poland. Coordination abilities were assessed in standardised testing conditions by the same group of researchers. The wrestlers performed all tests twice outside of their training schedule, i.e. in the morning just after sleep. Before testing, each subject was familiarised with the required procedures and then participated in an preliminary test to become acquainted with the equipment. Five tests from the VTS were performed [10, 14, 16] in the following order: RT (reaction test), DT (decision test), SIGNAL (signal detection test), 2HAND (hand coordination test) and MLS (motor performance test), each separated by two-minute intervals. These tests were broken up into thirty test scores that would be able to determine six CMA (quick reaction time including simple and complex reactions, spatial orientation, movement adaptability, movement coupling, frequency of movements and kinaesthetic differentiation).

The accuracy of the applied tests was checked on the basis of two criteria, i.e. their reliability and validity. Test reliability refers to the magnitude of measurement error. It defines the repeatability (stability) of the results by subjects taken at different times. That is to say, this criterion determines if an aspect under examination had been tested accurately [7, 17]. In order to define reliability, a test/retest method was used, where the tests were conducted twice over a three-to-five day period. Each wrestler repeated the test at exactly the same time of day. The obtained data were compared by calculating Pearson's correlation coefficient (labelled as: r) and Kendall's Tau coefficient (labelled as: tau). Test reliability was then estimated with the use of both statistical tests whose reliability coefficients were significant (α = 0.05) and higher than 0.50. In scientific research, the following ranges of a reliability coefficient are used: 0.99÷0.95 – excellent reliability; 0.94÷0.90 – good reliability; 0.89÷0.80 – acceptable reliability; 0.79÷0.70 – poor reliability. According to experts [8, 18], most coordination tests are short in nature, so a reliability index above 0.50 is considered sufficient for group diagnosis.

Test validity refers to the magnitude of measurement accuracy. A test is considered to be valid if it measures, first and foremost, the feature in question. Most often test validity is defined by a coefficient of correlation by using certain external criterion [7, 19]. In this study, it was decided that the validity of the selected scores would be determined with the help of three criteria, i.e. a summary rank evaluation of coordination preparation levels of wrestlers based on the battery of computer tests, a rank evaluation of technical-coordination preparation made by a coach and a rank evaluation on the basis of a wrestler's sporting level. As far as the third criterion is concerned (sporting level), the following factors were taken into consideration: effectiveness in sports competition, their sports result as well as the wrestler's commitment and attitude. Spearman's rank correlation was employed to assess validity. The index obtained was marked as "ρ". In order to meet the criteria of sports metrology [8, 18], an index of 0.30 was treated as being valid.

As previously mentioned, the study analysed six CMA (quick reaction time including simple and complex reactions, spatial orientation, movement adaptability, movement coupling, frequency of movements and kinaesthetic differentiation), scored on the basis of thirty variables that were assessed by various VTS tests. These were:

Quick reaction time and its factors, i.e. reaction time and single movement time, were assessed with the RT test (test form S1). Sitting in front of a monitor, a subject placed their dominant hand's index finger on a "rest key" found on the station's work panel (no forearm support). Immediately after seeing a yellow light flash on the monitor, the subject was to move their index finger and press the reaction key (a black rectangular key). The result was made up of three scored variables: A1 – median quick reaction time (time between seeing the stimulus, i.e. the yellow light, and pressing the reaction key, expressed in ms); A2 – median sensor reaction time (time between the stimulus and releasing the rest key, expressed in ms); and A3 – median single movement time (time between releasing the rest key and pressing the reaction key, expressed in ms).

Complex reaction speed was measured with the use of the DT test (test form S1). Sitting in front of a monitor, the subject reacted as quickly as possible to five visual stimuli, in the form of white, yellow, blue, green and red rings, that were shown on a monitor. Five reaction keys on the control panel were assigned to each of the colours, which the subject had to press with the right or left hand upon seeing the stimuli. In addition, two white rectangular lights against black background were included in the test, which, when turned on, required the subject to press a pedal on the floor with their right or left leg. Furthermore, two acoustic stimuli (high- and low-pitched sounds), when heard, required the subject to press the appropriate white rectangular key (either hand could be used). This test measured three components: B1 – number of correct reactions; B2 – number of incorrect and missed reactions; and B3 – median reaction time (s).

Spatial orientation was evaluated by the SIGNAL test (test form S2). Sitting in front of a monitor, a subject observed black spots that randomly changed their position against a white background. Any time when four spots formed a square, the subject was to press a green key on the work panel. The result consisted of two components: C1 – number of correct and delayed reactions, expressed as hits and C2 – median detection time (s).

Movement coupling, also known as hand-hand coordination, was evaluated by the 2HAND test (test form S2). It defined the speed and accuracy of simultaneously coordinating movements with the right and left hand based on a visual stimuli. With the help of two joysticks, the subject had to move a dot along a given track shown on the computer screen. The joysticks could move the dot either vertically and horizontally. The subject's task was to follow the track (from start to finish) as quickly and accurately as possible. Every deviation from the track was treated as an error. The result was determined by three components: D1 – mean time duration to complete the whole track (s); D2 – mean error time (s); D3 – percent error time (%).

Movement coupling was also assessed on the basis of the MLS test (test form S1), which scored nine test variables: E1 – inserting long pegs with the right hand. Sitting at a table with a work panel, the subject used his right hand (without any forearm support) to insert long metal pegs into 25 holes located on the right side of the work panel. The subject had to complete this test as quickly as possible. The score was determined by the time it took to insert the long pegs into the holes (s); E2 – inserting long pegs with the left hand. The test was the same as above but the subject performed the test with their left hand. The result was the time it took to insert the long pegs with the left hand (s); E3 – similar as above, it involved inserting the long pegs using both hand simultaneously. The result was the mean time it took to insert the long pegs with the right and left hand (s); E4 – a similar test to the ones above, this test measured the time it took to insert the short pegs with the right hand as quickly as possible, the score was the speed it took the complete the test (s); E5 – inserting short pegs with the left hand. Similarly, the result was the time it took to insert the short pegs with the left hand (s); E6 – inserting short pegs with both hands. The score was based on the mean time it took to insert the short pegs with the right and left hand (s); E7 – aiming with the right hand. Sitting by the table with the work panel on it, the subject used a stylus held in his right hand (without any forearm support) to insert the stylus as quickly as possible into 20 holes (sensors) lined up on the plate; E8 – aiming with the left hand. This test was similar to E7 except with the subjects using their left hand; E9 – aiming with both hands. Similar to the previous test, the subjects had to aim the stylus with both hands simultaneously. The results for scores E7 to E9 were made up of four components: (a) – total number of errors, (b) – total number of accurate hits, (c) – total time of errors (s), (d) – the sum of all times (s).

Movement adaptability was assessed using the MLS test (test form S1) with the help of three scored variables: F1 – the proportion of inserting long and short pegs with the right hand. Sitting by a table with the work panel on it, the subjects used their right hand (without any forearm support) to insert metal pegs (first long and then short ones) as quickly as possible into 25 holes located on the right side of the plate; F2 – similar to the F1 test, this measured the proportion of inserting long and short pegs with the left hand; F3 – the proportion of inserting long and short pegs with both hands. The scores of the tests (F1, F2, F3) were determined by the proportion of time of inserting long pegs to the time of inserting short pegs (%).

The frequency of movements was also evaluated on the basis of the MLS (test form S1) in terms of three scored variables: G1 – right-hand tapping. Sitting by the table with the work panel on it, the subject used a stylus held vertically in the right hand (without any forearm support) to tap as quickly as possible on the surface of a 4 mm square located on the right side of the plate; G2 – tested left-hand tapping; G3 – tapping with both hands. The results of G1, G2 and G3 was the sum of right-hand taps, left-hand taps and taps with both hands, respectively.

Kinaesthetic differentiation was also assessed with the MLS test (test form S1) by four scores, in which the first three tests (H1 – H3) were static in nature, while in the last one (I1) was a dynamic test: H1 – tested right-hand tremor. Sitting at the table with the work panel on it, the subjects used a stylus held in their right hand (without any forearm support) and inserted it into the proper hole (two hole diameters were used) without touching its edges; H2 – tested left-hand tremor; and H3 – tested tremor of both hands. The results for each of the scores were composed of two components: (a) – number of errors; (b) – error time (s). The final test was I1 – line tracking. Sitting by the table with the work panel on it, the subject used the stylus, held first in the right and then in the left hand, to trace a line (groove) in the work panel. Three components were scored: (a) – total number of errors; (b) – total error time (s), (c) – total time (s) [10, 13–16].

Results

Based on the wrestlers' results, the reliability of the VST computer tests used to assess CMA in wrestlers is shown in Table 1. The presented data indicates that only some of the applied tests can be considered reliable. Thirteen out of thirty CMA scores featured statistically significant ($p \leq 0.05$) reliability coefficients larger than 0.50 for both statistical tests, thus meeting the accuracy requirements within the specified criterion.

Scores assessing such CMA as quick reaction time

Table 1. The reliability of motor test scores assessing different coordination abilities in Greco-Roman wrestlers

Coordination ability	Test symbol (test form)	Test (variable)	Retest within 3–5 days	
			r	tau
Quick reaction time				
– simple reaction	RT (S1)	A1 – median quick reaction time (ms)	**0.71****	**0.53****
		A2 – median reaction time (ms)	**0.78****	**0.55****
		A3 – median single movement time (ms)	**0.53***	0.19
– complex reaction	DT (S1)	B1 – number of correct reactions (total)	**0.85****	**0.63****
		B2 – number of incorrect and missed reactions (total)	**0.57***	0.48*
		B3 – median reaction time (s)	**0.93****	**0.85****
Spatial orientation	SIGNAL (S2)	C1 – number of detected stimuli (total)	**0.58***	0.43*
		C2 – median detection time (s)	**0.89****	**0.98****
Movement coupling	2HAND (S2)	D1– mean time duration to complete the whole track (s)	**0.84****	**0.55****
		D2 – mean error time (s)	0.42*	0.29*
		D3 – percent time error (%)	**0.58****	0.49**
	MLS (S1)	E1 – insertion of long pegs with the right hand (s)	**0.67****	**0.51****
		E2 – insertion of long pegs with the left hand (s)	0.50	0.28
		E3 – insertion of long pegs with both hands (s)	**0.89****	**0.81****
		E4 – insertion of short pegs with right hand (s)	**0.67****	0.39*
		E5 – insertion of short pegs with left hand (s)	0.47	0.28
		E6 – insertion of short pegs with both hands (s)	**0.74****	0.43*
		E7 – aiming with the right hand		
		a) number of errors (total)	0.11	0.04
		b) number of accurate hits (total)	**0.56***	0.49
		c) error time (s)	0.27	0.03
		d) total time (s)	**0.69****	**0.61****
		E8 – aiming with the left hand		
		a) number of errors (total)	**0.53***	**0.53***
		b) number of accurate hits (total)	0.06	0.13
		c) error time (s)	0.38	0.38
		d) total time (s)	**0.72****	**0.53****
		E9 – aiming with both hands		
		a) number of errors (total)	0.21	0.17
		b) number of accurate hits (total)	0.02	0.01
		c) error time (s)	0.46	0.11
		d) total time (s)	**0.60***	**0.56****
Movement adaptability	MLS (S1)	F1 – proportion of inserting long and short pegs with the right hand (%)	**0.52***	**0.52****
		F2 – proportion of inserting long and short pegs with the left hand (%)	**0.51***	0.43*
		F3 – proportion of inserting long and short pegs with both hands (%)	**0.53***	0.18
Frequency of movements	MLS (S1)	G1 – right-hand tapping (total)	**0.80****	**0.69****
		G2 – left-hand tapping (total)	**0.69****	**0.52****
		G3 – tapping with both hands (total)	**0.78****	**0.58****
Kinaesthetic differentiation				
– static aspect	MLS (S1)	H1 – right-hand tremor	0.38	0.11
		a) number of errors (total)	0.42	0.24
		b) error time (s)		
		H2 – left-hand tremor	0.03	0.07
		a) number of errors (total)	0.09	0.19
		b) error time (s)		
		H3 – tremor for both hands	**0.71****	0.38
		a) number of errors (total)	0.36	0.26
		b) error time (s)		
– dynamic aspect		I1 – linear tracing	0.44	0.99
		a) number of errors (total)	0.14	0.01
		b) error time (s)	0.37	0.30
		b) total time (s)		

r – Pearson's correlation coefficient; tau – Kendall's Tau coefficient;
* $\alpha = 0.05$; ** $\alpha = 0.01$; values marked in bold indicate coefficients which meet the reliability criteria

Table 2. The validity of the motor test scores assessing different coordination abilities in Greco-Roman wrestlers

Coordination ability	Test (variable)	RN1 ρ	RN2 ρ	RN3 ρ
Quick reaction time – simple reaction	A1 – median quick reaction time (ms)	0.26	0.08	–0.26
	A2 – median reaction time (ms)	0.28	0.10	–0.03
– complex reaction	B1 – number of correct reactions (number)	–0.33*	–0.43*	–0.42*
	B3 – median reaction time (s)	0.32*	0.35*	0.49*
Spatial orientation	C2 – median detection time (s)	0.42*	0.27	0.46*
Movement coupling	D1– mean time duration to complete the track (s)	0.26	0.35*	0.51*
	E1 – insertion of long pegs with the right hand (s)	0.17	0.37*	0.35*
	E3 – insertion of long pegs with both hands (s)	0.50*	0.53*	0.38*
	E8a – number of errors (number)	0.54*	0.38*	0.32*
	E8c – error time (s)	0.66*	0.33*	0.37*
Movement adaptability	F1 – proportion of inserting long and short pegs with the right hand (%)	–0.51*	–0.42*	–0.44*
Frequency of movements	G1 – right-hand tapping (number)	–0.49*	–0.01	0.07
	G2 – left-hand tapping (number)	–0.46*	–0.01	–0.04
	G3 – tapping with both hands (number)	–0.49*	–0.06	–0.08
Summary rank evaluation of coordination preparation levels based on VTS (RN1)			0.74	0.54

RN1 – summary rank evaluation of coordination preparation levels based on the VTS tests
RN2 – summary rank evaluation of technical-coordination preparation assessed by a coach
RN3 – summary rank evaluation on the basis of the wrestlers' sports level
ρ – diagnostic informativeness coefficient for each CMA index
* denotes sufficient validity

including simple (A1÷A2) and complex reactions (B1, B3), spatial orientation (C2), movement coupling (D1, E1, E3, E8), movement adaptability (F1) and frequency of movements (G1÷G3) demonstrated reliability coefficients sufficient for assessing these abilities. In the case of scores assessing quick reaction time including simple (A3) and complex reactions (B2), spatial orientation (C1), movement coupling (D2, D3, E2, E4÷E7, E9), movement adaptability (F2, F3) and kinaesthetic differentiation both in a static (H1÷H3) and dynamic aspect (I1), the coefficients were found to be statistically insignificant with values below 0.50, which indicates that they are impractical for assessing these abilities in wrestlers.

Analysis revealed that the highest reliability was demonstrated by scores for spatial orientation (C2 – median detection time, r = 0.89; tau = 0.98), complex reaction (B3 – median reaction time, r = 0.93; tau = 0.85 and B1 – the number of correct reactions, r = 0.85; tau = 0.63), movement coupling (E3 – inserting long pegs with both hands, r = 0.89; tau = 0.81 and D1 – mean time duration to complete the track, r = 0.84; tau = 0.55) and frequency of movements (G1 – right-hand tapping, r = 0.80; tau = 0.69). In turn, the lowest but still satisfactory reliability level was observed in scores for movement adaptability (F1 – the proportion of inserting long and short pegs with the right hand, with a reliability coefficient of 0.52 for both statistical tests) and movement coupling (E8 – left-hand hitting, where the reliability coefficients ranged from 0.53 to 0.72).

The validity of the thirteen CMA scores that were screened beforehand for reliability are shown in Table 2. The data obtained indicate that regardless of the assumed criterion, the majority of the scores demonstrated a validity coefficient of no less than 0.30.

In the case of scores assessing quick reaction time including simple reactions (A1, A2) and the frequency of movements (G1÷G3), the validity coefficients turned out to be insufficient. Only eight out of the thirteen scores examining four CMA, complex reaction (B1, B3), spatial orientation (C2), movement coupling (D1, E1, E3, E8) and movement adaptability (F1), demonstrated coefficients above 0.30, thus meeting the assumed accuracy criterion.

Based on the data presented in Table 2, it may be concluded that in comparison to the single scores of CMA, the highest validity level is demonstrated by the summary rank evaluation of coordination preparation, where the validity coefficient was found to be above 0.30 in nine out of thirteen scores. By comparing the validity of this criterion with other scores, it may be stated that a higher validity coefficient is observed in the case of the rank evaluation of technical-coordination preparation made by a coach, at $\rho = 0.74$. Taking into account the rank evaluation of a wrestler's sports level, the validity of the coordination tests under examination was 0.54.

Discussion

An analysis of the VTS computer tests that can be used to monitor CMA in wrestling, on the basis of two accuracy criteria, revealed that eight out of thirty scores evaluating six coordination abilities met the requirements put forward during the analysis. These eight scores measured only four CMA, and were: quick reaction time during a complex reaction (B1 – number of correct reactions, and B3 – median reaction time), spatial orientation (C2 – median detection time), movement coupling (D1 – mean time duration to complete the track; E1 and E3 – inserting long and short pegs with the right hand, and with both hands, respectively; E8 – aiming with the left hand) and movement adaptability (F1 – the proportion of inserting long and short pegs with the right hand).

The reliability of the scores evaluating quick reaction time, frequency of movements and partial spatial orientation (median detection time), movement adaptability (the proportion of inserting long and short pegs with the right hand) and movement coupling (mean time duration to complete track, inserting long pegs with the right hand and with both hands, and aiming with the left hand) ranged from 0.53 to 0.98, which proves that these tests have sufficient reliability. As for the tests assessing kinaesthetic differentiation and partial movement adaptability (the proportion of inserting long and short pegs with the left hand and with both hands), movement coupling (mean time and percent error; inserting long and short pegs with the left, right and both hands; and aiming with the right hand and with both hands) and spatial orientation (the number of detected stimuli), the criterion under examination was not fulfilled.

Out of all the tests, insufficient validity was mainly demonstrated in the scores measuring simple reactions and frequency of movements; therefore they should not to be used in diagnosing CMA in wrestlers. Particular attention should be paid to the tests assessing movement coupling, which demonstrated relatively low validity levels. The most probable reason for this may stem from the fact that the tests were performed by right-handed wrestlers alternately with their right and left hands, which created a rather distorted picture of their coordination preparation.

As for validity, the obtained data indicated that regardless of the assumed criterion, the majority of the scores under examination demonstrated a validity coefficient of no less than 0.3. Such a value meets the criteria set out in sports metrology on study validity and it shows that these tests are useful in diagnosing CMA. According to researchers analysing CMA, index values of 0.50 for reliability and 0.30 for validity may be considered sufficient. These values themselves were lowered due to the involvement of the nervous system and its susceptibility to various stimuli, i.e. emotional stress, weather, attitude, motivation, etc. [7, 8, 18–20].

In assessing the validity of the applied tests, considerable differences were observed depending on the assumed criterion. This may have been caused by discrepancies stemming from different experts' subjective evaluations of a wrestler's sports level or their technical-coordination preparation. Standardising tests and increasing their validity may come about through a more thorough analysis of various tests and test forms used in the VTS test battery. This would aid the assessment of specific CMA in wrestlers as well as increasing the competence and conformity of opinions of researchers that are investigating this matter.

As far as the training process used in wrestling is concerned, the results confirm the usefulness of the assessments carried out by using appropriate VTS computer tests. Such tests may be conducted at different periods over a season in order to measure the changes in CMA development resulting from different training loads implemented at various training stages. They may also be used to define the structure of CMA by correlating them to conditioned abilities, technical performance, somatic scores and psychological functions. Moreover, they may be applied to determine the influence of targeted coordination training on the effectiveness of technical-tactical activities and on the speed and quality of acquiring new motor skills. Tests with high reliability and validity may turn out to be very useful in the selection of athletes for competition as well as for predicting sports results.

Therefore, the diagnostic procedure applied in this study seems to be a valuable research tool, which was borne out other author's research to monitor athletes' training processes [8, 9, 12, 21]. However, it must be emphasised that research in the field of using test batteries (especially based on computer testing) to evaluate CMA seems to be one of the least explored areas in the theory of sports and sport metrology [4–7, 22]. Additional research is needed in this regard, particularly in sports with complex movement structures, such as combat sports and wrestling.

Conclusions

The above-mentioned considerations concerning the reliability and validity of computer tests have led to the following conclusions:

1. Thirteen out of the thirty CMA scores under in-

vestigation demonstrated sufficient reliability coefficients. Tests assessing quick reaction time, frequency of movements, partial movement coupling, spatial orientation and movement adaptability meet the assumed reliability criterion.

2. In most cases, the validity coefficients were not lower than 0.3. The highest validity score was found in the tests measuring movement coupling, complex reactions, spatial orientation and movement adaptability, while simple reactions and frequency of movements featured the lowest validity.
3. The obtained reliability and validity coefficients of the scores of complex reactions, partial spatial orientation, movement adaptability and movement coupling confirm the usefulness of these specific tests in diagnosing CMA in wrestlers, as they meet the demands of sports metrology.
4. Coaches and wrestlers ought to take such assessments of predominant CMAs into account, particularly at a wrestler's initial stages of training.

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Correspondence address
Dariusz Gierczuk
Zakład Teorii Sportu
Wydział Wychowania Fizycznego i Sportu
ul. Akademicka 2
21-500 Biała Podlaska, Poland
e-mail: darekgierczuk@op.pl