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Extract from dissertation thesis

**DEVELOPMENT OF TEST BATTERIES FOR DIAGNOSTICS OF MOTOR
LATERALITY MANIFESTATION – LINK BETWEEN CEREBELLAR
DOMINANCE AND HAND PERFORMANCE**

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INTRODUCTION

Laterality is strong characteristic of human which determined left-right asymmetry. Laterality can be either morphological or functional. Morphological laterality assesses disproportions of parts of the body and organs (Mohr, Thut, Landis, & Brugger, 2003). Functional laterality is understood as asymmetry of locomotive (hands, legs) or sensory (an eye, ear) paired organs (Hatta, Ito, Matsuyama, & Hasegawa, 2005) that is demonstrated by preferred use of one the paired organs.

Functional laterality is a sign of brain activity that is reflected both in the motor activity of motor organs and direction and the coding of (the impulse of) the signal through sensory organs, both paired and unpaired (tongue). Control of motor activity is projected onto paired motor organs differently, which is expressed by different levels of motor manifestations of the left or right motor organ (legs, hands). The direction and coding of the signal, which, in the form of an impulse, is processed by a sensory organ, is usually based on a different function of this paired organ: different processing of auditory information by the right and left ear; different processing of visual information by the right and left eye.

Therefore, functional laterality means functional asymmetry of paired motor organs (hands, legs) or paired sensory organs (eyes, ears) (Hatta, Ito, Matsuyama, & Hasegawa, 2005). This is manifested in the preferred use (preference) of one of the paired organs, which usually also operates faster or better. Functional lateralization is thus a reflection of the dominance of one cerebral hemisphere (Annett, 1985; Bryden, 2000; Mohr, Landis, Bracha, & Brugger, 2003). In addition to traditional approaches to the assessment of motor manifestations of laterality, which are often used to determine the dominant cerebral hemisphere (questionnaire, preference task), we tried to evaluate new diagnostic approach. It is the determination of cerebellar dominance, which, according to Professor Henner's hypothesis, should be directly related to motor manifestations of laterality or hemispheric superiority. Professor Henner assumed that muscle tone which is controlled by cerebellum has direct link to laterality (Henner, 1927).

AIM OF THESIS

The aim of this study is to contribute to the standardization of the new diagnostic tools assessing the motor manifestations of laterality in adults and children aged 8 to 10 years, both in terms of determining the theoretical concept and the selection of

appropriate items, and the verification of structural hypotheses concerning the design of acceptable models, including the diagnostic quality of individual parts of the test battery. Moreover in this study we try to suggest new approach in assessing of motor laterality manifestation by means of relationship between cerebellar dominance and hand performance through measurement of articularis passivity.

STRUCTURE OF THESIS

The first part of this thesis deals with the concept of laterality, its manifestations and meaning in non-living systems and living organisms. As a human characteristic, laterality is manifested in a variety of functional and structural asymmetries. This part also discusses ways of diagnosing motor manifestations of laterality its methodological and psychometrical shortcomings. Lastly in this part there is discussed the issue of cerebellar dominance, including its reflection in the form of asymmetry of the extinction physiological syndrome of upper limbs.

The second part focuses on the process of the standardization study, the statistical method of structural equation modelling, and the actual design of test battery construction.

The last part of this thesis presents the results of structural equation modelling, i.e., the dimensionality and diagnostic quality, including the reliability of various proposed models.

RESEARCH QUESTIONS

- What is the diagnostic quality of all items (both existing and newly created) used to diagnose motor manifestations of laterality?
- Which empirical indicators should be chosen to determine the individual constructs of handedness and footedness using motor performance tests?
- Does it exist significant relationship between hand performance and cerebellar dominance?

METHODS

This thesis represents empirical quantitative research focused on definite relation between manifest and latent variables. Character of study can be named as standardization study. Therefore we will focus on the definition of the theoretical concept, the selection of items and research sample, and the expression of the diagnostic quality of individual parts of the test battery. Standardization studies fall into “tightly structured research”. They come mostly from the field of quantitative research, which firmly determines the structure of the research plan with clear and specific research questions, clear conceptual framework, and structured scheme (Punch, 2008). In this case, the actual design of the research plan is the most critical point of the entire research process (Brink, & Wood, 1994).

In order to form the test batteries within the standardization procedure, we used the principles of psychometry, which is a theoretical and interdisciplinary tool for creating high-quality diagnostic methods (Michell, 1997).

Determination of Structure of Diagnostics Tool:

We determined the concept of two test batteries for both the adult and child populations. The concept of both test batteries has the same basis, i.e., an assessment of preference and performance of motor organs with the quantification of ocular dominance. Based on the ontogeny of cognitive functions and human motor activity, with respect to the adult population, we decided to use a test battery that would assess the motor manifestations of laterality in three ways. The first part of the test battery, which will display the screening nature, will form a short questionnaire (containing no more than ten items) determining upper and lower limb preference. This part should identify the basic lateral trend of adult individuals.

The second part of the test battery will consist of up to eight motor tasks determining upper and lower limb preference. The tasks (in the form of spontaneous motor activity) should specify the lateral trend of preference. This part of the test battery will also determine ocular dominance using a motor task.

The third part will include performance tests that will assess differences in the performance of both upper and lower limbs. It will contain up to eight indicators. An indicator determining cerebellar dominance will also be implemented in this part of the test battery. The test battery for the diagnosis of motor manifestations of laterality in the

adult population will not contain more than 26 indicators. Based on the consultation with the Institute of Pedagogical and Psychological Counselling, the time of diagnosis should not exceed 20 minutes.

Due to the lower levels of self-perception with respect to lateral manifestations, the test battery designed for the child population aged 8–12 years will not contain the questionnaire part and will assess motor manifestations of laterality in two ways.

The first part of the test battery will consist of up to twelve motor tasks for assessing upper and lower limb preference. Based on the motor task focused on the eye sighting factor, ocular dominance will be determined.

The second part of the battery will include performance tests that will assess differences in performance of both upper and lower limbs. This part will contain up to eight indicators, including an indicator determining cerebellar dominance. The entire test battery for the diagnosis of motor manifestations of laterality in the adult population will not contain more than 20 indicators. Based on the consultation with the Institute of Pedagogical and Psychological Counselling, the time of diagnosis should not exceed 15 minutes.

Creating a Complete List of Relevant Items:

The creation of a list of relevant items was based on the batteries and individual indicators already standardized, as well as on the ontogeny of human motor activity and maturation of the human central nervous system.

The test battery designed for the adult population.

The list of relevant items for the creation of the questionnaire part of the test battery primarily consists of indicators that display the nature of unimanual tool questions. These are items that reflect the motor activity of common everyday activities.

The preferential tasks for upper and lower limbs represent activities of a unimanual nature. It is not necessary that the subjects have experience of the activities. When selecting preferential tasks, particular emphasis was laid on the simplicity and low material requirements of the motor tasks.

In order to determine the different performance of upper and lower limbs, performance tests are based on both gross and fine motor activity. In order to determine the level of the upper limb fine motor activity, tests for separate involvement of the

distal part as well as for the joint involvement of proximal and distal parts have been used and developed.

The indicator for determining cerebellar dominance is based on the determination of the level of articular passivity in the wrist.

The test battery designed for the child population.

Preferential tasks for upper and lower limbs focus on motor activity of a unimanual nature. Relevant indicators for the upper limb in the part containing preference tasks are primarily focused on motor activity where the proband will work across the natural body axis. During the selection and creation of preference tasks, particular emphasis was laid on the simplicity and low material requirements of the motor tasks.

In order to determine the different performance of upper and lower limbs, performance tests are based on both gross and fine motor activity. In order to determine the level of the upper limb fine motor activity, tests for separate involvement of the distal part as well as for the joint involvement of proximal and distal parts have been used and developed.

The indicator for determining cerebellar dominance is based on the determination of the level of articular passivity in the wrist.

The complete list of relevant items for the creation of the test battery for the adult population contained 75 indicators assessing motor manifestations of upper limb laterality, 34 indicators assessing motor manifestations of lower limb laterality, and 1 indicator assessing the sighting factor of ocular dominance. The list of relevant items for the creation of the test battery for the child population contained 51 indicators assessing motor manifestations of upper limb laterality, 22 indicators assessing motor manifestations of lower limb laterality, and 1 indicator assessing the sighting factor of ocular dominance.

Content Validity:

This method is based on the agreement between independent panellists (experts) who, based on their knowledge of the issue, decide the extent of the fundamental importance that a certain item has for the reflection of the construct (Lawshe, 1975).

These panellists should form a heterogeneous group, each of them seeing the issue from a different perspective (Štochl, & Musálek, 2009).

When creating a scale assessing the content validity of indicators, two types of scales were considered: a scale with an even number of options and scale with an odd number of options. In our case, in order to assess the content validity of indicators, we finally decided to create the five-point Likert scale which did not contain a neutral option and, simultaneously, displayed a fine distinction between individual degrees of the indicators' content validity with regard to the defined theoretical concept:

1. the indicator does not measure the theoretical concept at all
2. the indicator measures the theoretical concept weakly
3. the indicator measures the theoretical concept
4. the indicator measures the theoretical concept strongly
5. the indicator measures the theoretical concept very strongly

In order to assess content validity, the lists of relevant indicators for both the adult and child populations were sent to six experts from different disciplines related to the motor manifestations of laterality. The following disciplines were used: special education, neurology, psychiatry, anthropometrics, kinesiology, and neurophysiology. All experts were informed of the aim of this thesis, and in addition to the assessment of the indicators' content validity, the experts were asked to specify whether the indicator is appropriate in the form of the question in the questionnaire, motor task, or motor test. This specification was conducted by the experts by assigning shortcuts to the indicators:

Q question in the questionnaire

PT preference task

PET performance test

The calculation of conformity was carried out according to the formula

$$CVR = \frac{(n_e - \frac{N}{2})}{(\frac{N}{2})} \quad (\text{Lawshe, 1975}).$$

Subsequently, we selected the indicators where all

experts repeatedly agreed on the value of 5. Then we incorporated the indicators where more than half of experts agreed on the value of 5, but other panellist(s) assigned the

value of 4 to this item. The last part of the indicators included in the creation of the test batteries was represented by items to which all the panellists assigned the value 4.

The Research Sample and Its Size:

The specification of the research samples was based on two fundamental aspects:

The first was the need for diagnosis, especially in the child population, which could reveal the cause of possible specific disorders.

The second was the practical aspect of availability of the research sample. The selection area of our research sample was the City of Prague. We based the selection on the results of studies which suggest that the ratio of left-sided and right-sided normally developing individuals in many populations is 1:9. Therefore, we do not assume that this ratio would be currently different in different parts of the Czech Republic. The first research sample consisted of children aged 8 to 10 years. At this age, the lateralization process is still at the fixing phase, and it is a period with a very high occurrence of a variety of specific disorders. The second research sample was represented by young people aged 17 to 19 years. At this age, the lateralization process is already completed, and the test battery can be used to diagnose adults. The probands representing the child population were individuals from state primary schools of the City of Prague which had no specific specialization (arts, technology, sports, languages), and their classes contained no integrated children. The probands representing the adult category were students of Prague general upper secondary schools without a specific specialization (arts, technology, sports, languages).

The final research sample size for the adult population was set at 440 probands (212 men and 228 women) aged 17–19 years (average age 18.2 years). Due to availability, the research sample size of the child population was eventually adjusted to 400 probands (193 boys and 207 girls) aged from 8 to 10 years (average age 9.1 years).

In order to support the selection, we used a complete list of primary schools and four-year and multiple-year general upper secondary schools from the City of Prague which we obtained at the Institute of Educational and Psychological Counselling. With respect to the complexity of a randomized selection of probands from Prague schools and accurate definition of the area of the City of Prague, we decided to obtain both research samples based on the method of purposive sampling which met the following

conditions. In co-operation with the Institute of Educational and Psychological Counselling, both secondary and primary schools from each district of the city were selected. As we set the number of the tested individuals at one school to 40, only those schools that were attended by at least 50 individuals of the given age were selected. Out of these schools, a list was created from which one primary school and one secondary school were randomly selected from each district of Prague. In total, 10 primary schools and 11 secondary schools were selected. Due to the large number of items in both test batteries, we subsequently decided to divide both research samples into two halves. Each part of the research sample of the adult population included 220 individuals. Each part of the research sample of the child population included 200 probands. Furthermore, two versions of the test battery were also created for each population. Several of the strongest identical indicators, chosen based on the results of the content validity, were incorporated in both versions. Other indicators were different in both versions.

Final versions of Test Batteries Before Collecting the Data:

A) ADULT POPULATION:

Questionnaire:

Based on the results of the content validity, the following 4 strongest indicators were selected for both versions of the test battery:

- Which hand do you use to hold a writing instrument for drawing?
- Which hand do you use to hammer a nail into wood?
- Which hand do you use to hold a knife when cutting bread?
- Which foot do you use to kick a ball?

The remaining 11 items of the questionnaire part were divided: 6 items were added to the first version, and 5 items were added to the second version, i.e. one version of the test battery contained 10 items in the questionnaire part, and the second version of the test battery contained 9 items.

Preference motor tasks:

Based on the results of the content validity, the following 3 strongest indicators were selected for both versions of the test battery:

- Throw the ball at the target.

- Erase the drawn line.
- Demonstrate how you would write the letter T on the floor using one of your feet.

The remaining 13 motor tasks were divided: the groups of 7 items were added to both versions of the test battery, to the 3 strongest indicators. One version of the test battery contained 10 items in the preference tasks part, and the second version of the test battery contained 9 items. Separately there was one item for assessing eye dominance.

Performance tests:

Based on the results of the content validity, the following 4 strongest indicators were selected for both versions of the test battery – two for the upper limb and two for the lower limb:

- Tracing the spiral
- Dot-filling fine motor test
- Lower limb tapping
- Slalom with a ball between obstacles

Subsequently, the item for the diagnosis of cerebellar dominance was implemented into these tests (into both versions of the test battery).

Of the remaining 11 performance tests, 5 were added to one version and 6 to another version, i.e. one version of the test battery contained 9 indicators in the performance test part, and the second version of the test battery contained 10 indicators.

B) CHILD POPULATION

Preference motor tasks:

Based on the results of the content validity, the following 4 strongest indicators were selected for both versions of the test battery:

- Draw a leaf according to the model.
- Ring the bell.
- Throw the ball at the target.
- Kick the ball at the target.

The remaining 18 motor tasks were divided: 9 tasks were added to each version, to the strongest indicators, i.e. the preference motor task part contained 13 indicators in both versions of the test battery. Separately there was one item for assessing eye dominance.

Performance tests:

Based on the results of the content validity, the following 4 strongest indicators were selected for both versions of the test battery – two for the upper limb and two for the lower limb:

- Tracing the spiral
- Dot-filling fine motor test
- Lower limb tapping
- Slalom with a ball between obstacles

Of the remaining 10 tests, 6 were added to each version of the test battery to the 4 strongest indicators. In the performance test part, each version contained 10 indicators.

Subsequently, the item for the diagnosis of cerebellar dominance was implemented into these tests (into both versions of the test battery).

Data Analysis, Evaluation of Structure:

In this study, in order to determine the structure of motor manifestations of laterality in indicators of continuous nature, we decided to use Structural equation modelling concrete confirmatory factor analysis (CFA) for interval data from performance test parts. To verify prerequisite for the use of CFA the multivariate normality we used Cox-Small Test. In all four parts of performance tests (two versions for the child population and two versions for the adult population), possible multicollinearity was first investigated using correlation matrices. Multicollinearity was subsequently excluded, based on the results. When determining the model itself, a two-factor structure was always set as a basis, i.e., in all versions of the test battery, in the performance test part. One factor formed hand performance, and the second factor formed foot performance. Character of data in questionnaire and preference tasks part was ordinal or dichotomised. Therefore these data had to be analysed by non-linear technique which used tetrachoric correlations for categorical binary data, and polychoric

ordinal correlations for categorical polytomous data. This procedure is called categorical confirmatory factor analysis (CCFA). CCFA is a statistical technique that, by its nature, falls into Item Response Theory (IRT) (Forero, & Maydeu-Olivares, 2009). For analyzing data we used M-plus program (Muthén, & Muthén, 2010)

RESULTS

TEST BATTERY FOR ADULT POPULATION

a) Questionnaire

The data in both versions of the questionnaire part was scored on the five-point Likert scale. It is thus a categorical data of polytomous character. Due to the categorical data type, the WLSMV method was used as a parameter estimation.

The items of the questionnaire part of the first version of the test battery:

- Which hand do you use to hold a writing instrument for drawing? **HD**
- Which hand do you use to hammer a nail into wood? **NA¹**
- Which hand do you use to hold a knife when cutting bread? **KC**
- Which hand do you use to hold a toothbrush when brushing your teeth? **THB**
- Which hand do you use to hold a rubber when erasing? **ER**
- Which hand do you use to hold a key when unlocking the door? **UNL**
- Which hand do you use to hold a glass if you want to drink? **GD**
- Which foot do you use to kick a ball? **KB**
- Which foot do you place on the first step when walking upstairs? **ST**
- While standing, which of your lower limbs do you place forward when you want to slide without the support of your hands? **SLI**

¹ This item is scored reversely therefore, the analysis contains a negative loading for this item. The person being tested is not deliberately asked about the preferred upper limb but about the non-preferred upper limb in order to hold the attention of the persons being tested

Final model from first version :

Table 1

Fit of the 1-factor model questionnaire 1. version of test battery without items HD, GD and ST (adult population)

Model	Chi-square	P-value	df	CFI	TLI	RMSEA	WRMR
1-factor	16.25	0.29	14	0.99	0.99	0.028	0.381

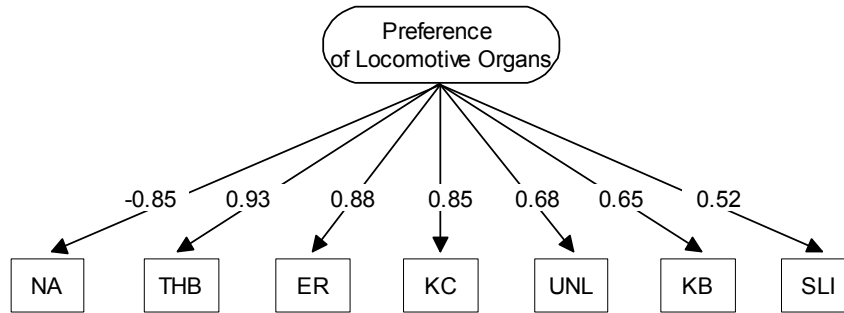


Fig. 1 Path diagram of 1-factor model questionnaire 1. version of test battery without items HD, GD and ST (adult population)

This one-factor structure of the questionnaire part proved to be the most appropriate in the first version of the test battery.

Table 2

Generic reliability – questionnaire part 1. version (adult population)

Name of the factor	McDonald ω
Preference of Locomotive Organs	0.90

The questionnaire part items of the second version of the test battery:

- Which hand do you use to hold a writing instrument for drawing? **HD**
- Which hand do you use to hammer a nail into wood? **NA²**
- Which hand do you use to hold a match when lighting it? **MAT**

² This item is scored reversely therefore, the analysis contains a negative loading for these items. The person being tested is not deliberately asked about the preferred upper limb but about the non-preferred upper limb in order to hold the attention of the persons being tested

- Which hand do you use to hold a spoon when eating? **HS**
- Which hand do you use to hold a plate when drying it? **WE³**
- Which hand do you use to hold a knife when cutting bread? **KC**
- Which foot do you use to kick a ball? **KB**
- Which lower limb do you use to stand on one leg? **STA**
- Which foot do you put a shoe on first? **SHO**

Final model from second version

Table 3

Fit of the 2-factor model questionnaire 2. version of test battery without items HS and HD (adult population)

Model	Chi-square	P-value	df	CFI	TLI	RMSEA	WRMR
2-factor	26.04	0.016	13	0.98	0.97	0.071	0.573

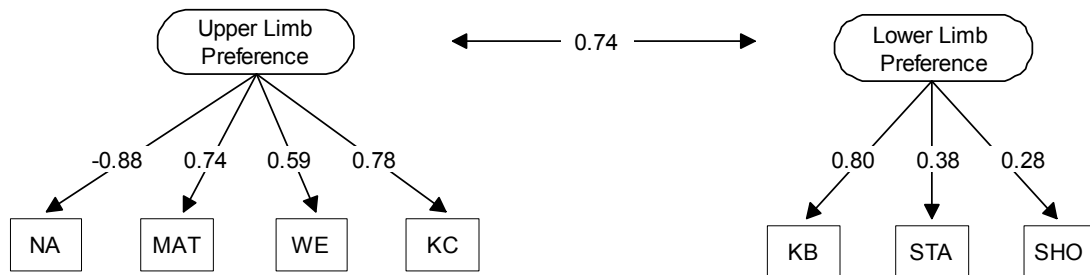


Fig. 2 Path diagram 2-factor model questionnaire 2. version of test battery without items HS and HD (adult population)

This two-factor model in the questionnaire part of the second version of the test battery finally showed the best model fit. However, this proposed structure did not achieve a level of diagnostic quality like the resulting structure of the questionnaire part of the first version of the test battery

³ This item is scored reversely therefore, the analysis contains a negative loading for these items. The person being tested is not deliberately asked about the preferred upper limb but about the non-preferred upper limb in order to hold the attention of the persons being tested

Table 4*Generic reliability – questionnaire part 2. version (adult population)*

Name of the factor	McDonald ω
Upper Limb Preference	0.83
Lower Limb Preference	0.51

The generic reliability value in the “Lower Limb Preference” factor, McDonald $\omega = 0.51$, was also unacceptable.

Summary:

The final form of the questionnaire consists of a one-factor structure from the first version of the test battery which met all the assumptions of diagnostic quality of the model acceptability. The CCFA results of the questionnaire parts also suggest that the items of skilled character for assessing the level of preference for both upper and lower limbs represent more of a unidimensional structure. This assumption is supported by the very nature of the testing. The questionnaire determining the degree of preference of upper and lower limbs has a self-assessment nature, so it is likely that the respondents’ answers may be influenced by subjective opinions. Another possible explanation is the very nature of the items. Since the tested individuals could choose from five options in each item, the questions in the questionnaire had to be related to standard activities known by everybody from everyday life, so every individual is able to determine the degree of preference in the activity. However, the questions with such a focus in the self-assessment questionnaire usually display the nature of activities subject to imitation or social pressure. In the actual result of the modelling of the questionnaire parts, support for this assumption can be found in the form of weaker factor loadings in activities that are not subject to the current right-sided world.

The UNL item (Which hand do you use to hold a key when unlocking the door?) is based on a non-skilled activity, and perhaps for this reason the factor loading is not so strong. The weakest item in this part of the test battery is SLI (While standing, which of your lower limbs do you place forward when you want to slide without the support of your hands?). The character of this item shows the spontaneous activity that is probably also related to the rotation attribute. However, after removing this item, there was a significant deterioration of the entire model fit, including the P-value.

b) Preference Tasks:

The data in this part of the test battery is scored dichotomously; therefore, the WLSMV method was used as a parameter estimation. We decided to use as general the two-factor model:

- “Upper Limb Preference”,
- “Lower Limb Preference”.

Preference task items of the first version of the test battery:

- Throw the ball at the target. **THR**
- Erase the line. **ER**
- Demonstrate how you would comb your hair. **CO**
- Use the pointer to point at the following object. **PO**
- Demonstrate how you would spread butter on bread. **SPR**
- Demonstrate how you would write the letter T on the floor using one of your feet. **WT**
- Perform standing on one leg. **ST**
- Kick the ball at the target. **KB**
- Move the cube on the floor using one of your feet. **MC**
- Demonstrate a long jump. **LJ**

Use the tube to look at the object. **LT**

The motor task **LT** “Use the tube to look at the object”, which is included in both versions of the test batteries, was not used in the structural equation modelling method. In order to express the relationship between this indicator and motor manifestations of laterality, using the tetrachoric correlation, the LT indicator was correlated with the final indicators that formed the most suitable model of preference tasks in the test battery designed for the adult population.

Final model from first version

Table 5

Fit of the 1-factor model preference tasks 1. version of test battery without items PO, MC, LJ a THR (adult population)

Model	Chi-square	P-value	df	CFI	TLI	RMSEA	WRMR
1-factor	19.29	0.24	9	0.99	0.99	0.026	0.543

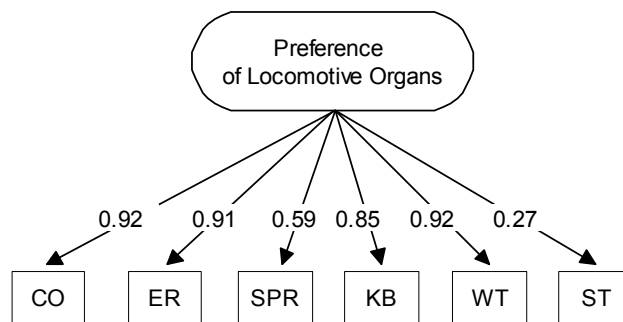


Fig. 3 Path diagram 1-factor model preference tasks 1. version of test battery without items PO, MC, LJ a THR (adult population)

Table 6

Generic reliability – preference part 1. version (adult population)

Name of the factor	McDonald ω
Preference of Locomotive Organs	0.89

Despite the fact that this model showed a fit deterioration, the one-factor structure was chosen as more appropriate and easier to interpret for the preference task part in the first version of the test battery.

Preference task items of the second version of the test battery:

- Throw the ball at the target. **THR**
- Erase the lines. **ER**
- Ring the bell. **RI**

- Use the pointer to point at the following objects. **POC⁴**
- Clap your hands. **CL**
- Demonstrate how you would write the letter T on the floor using one of your feet. **WT**
- Kick the ball at the target. **KB**
- Perform jumps forward using one leg. **HOP**
- Perform the basic (starting) position, and then step forward. **STO**
- Make a 360-degree turn. **TU**

Use the tube to look at the object. **LT**

Final model from second version

Table 7

Fit of the 2-factor model preference tasks 2. version of test battery without items RI, TU and STO (adult population)

Model	Chi-square	P-value	df	CFI	TLI	RMSEA	WRMR
2-factor	13.13	0.43	13	0.99	1.00	0.017	0.494

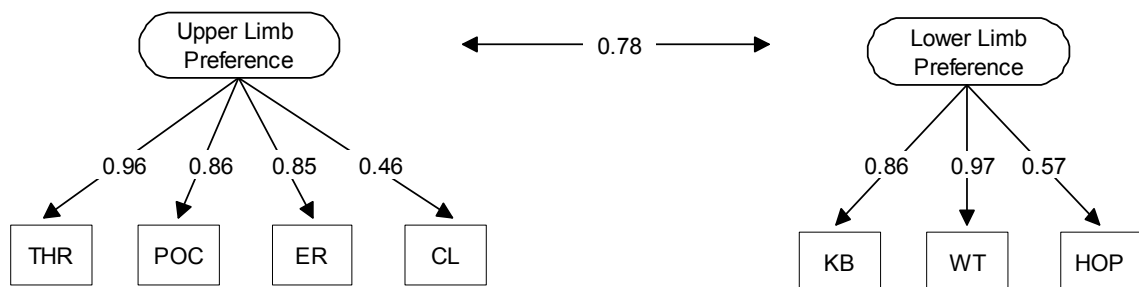


Fig. 4 Path diagram 2-factor model preference tasks 2. version of test battery without items RI, TU and STO (adult population)

⁴ This task is performed across the natural body axis of the individual

The proposed model with two separate factors for upper limb preference and lower limb preference showed a significant improvement of all fit index values, including the model significance expressed by the P-value = 0.43.

Table 8

Generic reliability – preference tasks 2. version (adult population)

Name of the factor	McDonald ω
Upper Limb Preference	0.89
Lower Limb Preference	0.85

Along with motor tasks assessing motor organ preference, ocular dominance was determined in both versions of the test batteries using the LT indicator (Use the tube to look at the object.). Therefore, we correlated the LT indicator with individual preference tasks contained by the two-factor model, adopted from the second version of the test battery.

- Throw the ball at the target. **THR**
- Erase the lines. **ER**
- Use the pointer to point at the following objects. **POC**⁵
- Clap your hands. **CL**
- Demonstrate how you would write the letter T on the floor using one of your feet. **WT**
- Kick the ball at the target. **KB**
- Perform jumps forward using one leg. **HOP**

Tetrachoric correlations were used in the matrix. The significance of these correlations was assessed. The significance of the correlations was set at $p < 0.05$.

⁵ This task is performed across the natural body axis of the individual.

Table 9*Correlation matrix hand preference tasks and eye dominance (adult population)*

	THR	POC	ER	CL	KB
THR					
POC	0.723				
ER	0.778	0.794			
CL	0.419	0.357	0.459		
KB	0.779	0.607	0.475	0.201	
WT	0.752	0.656	0.535	0.303	0.806
HOP	0.427	0.328	0.238	0.097	0.439
LT	0.282*	0.077	0.171	0.146	0.326*

SAMPLE TETRACHORIC CORRELATIONS			
	WT	HOP	LT
HOP	0.411		
LT	0.483*	0.185	

*significance correlation $p < 0.05$

Surprisingly, the correlation matrix shows that the LT indicator displays two significant correlations with motor tasks assessing lower limb preference KB (Kick the ball at the target) and WT (Demonstrate how you would write the letter T on the floor using one of your feet) and only one significant correlation with the motor task assessing upper limb preference (THR), although literature reports 80% lateral correspondence of hand preference and ocular dominance (measured by means of the sighting factor) (Bourrasa & McManus, Bryden, 1996).

Summary:

Based on the results of the analysis of the questionnaire part, in the preference task also we expected strong factor loadings in items of an instrumental or skilled nature related to upper and lower limb preference. This assumption was confirmed.

The “Upper Limb Preference” factor contains 4 items, none of them displaying the same course of motor pattern. The character of the motor task THR, based on throwing at the target, activates the entire upper limb in terms of movement, so this task involves the work of both distal and proximal parts of the upper limb. Apart from the motor activation of the entire upper limb, the POC indicator (Use the pointer to point at the following objects pointing across the natural body axis) also includes determination of the spatial advantage of pointing at the object. This motor task assumes that the more varied the upper limb sidedness of the subject is, the higher probability that the person also uses the non-preferred upper limb when pointing at objects across the natural body

axis. The motor task ER (Erase the lines) particularly activates the area of the hand and fingers. It is, therefore, an activity that mainly involves the distal part of the upper limb in the movement. The lowest factor loading in this model, in the factor “Upper Limb Preference”, was displayed by the CL indicator (Clap your hands.). This indicator has the character of unskilled motor activity that is not subject to any obvious imitation or pressure of the socially-culture environment. This activity is the only one to display a bimanual nature. The preferred hand is the controlling hand in this task, and the non-preferred hand has a supportive function.

The three indicators determining lower limb preference displayed the strongest factor loadings in the motor task WT (Demonstrate how you would write the letter T on the floor using one of your feet.). This task has the nature of a static skilled activity that places emphasis on the right lower limb movement in the sagittal and frontal plane. The second indicator is KB (Kick the ball at the target.) which represents a skilled task associated with the control and management of the tool that the subject has to set in motion in a certain direction. The motor task HOP (Perform jumps forward using one leg.) places emphasis mainly on the stability of the lower limb in the cyclical jump movement. This involves unskilled activity that had the weakest correlation to the “Lower Limb Preference” factor in this model. Compared to the two remaining indicators, this different tightness of the relationship is probably caused by the unskilled nature of this task, along with a different foundation of the motor pattern.

c) Performance Tests

The data in this part of the test battery are of an interval nature. Both versions of the draft performance tests included tests with the reverse scoring character. These were the tests in which time was not a constant.

Performance test items of the first version of the test battery:

- Tracing the spiral **SP**⁶
- Dot-filling fine motor test **DO**
- Grip strength using a dynamometer **HGR**
- Arranging matches within a limited area using tweezers **MAC**

⁶ Time is not a constant in this test, so the factor loading indicates a negative value.

- Moving beads from one box into another using tweezers **TW**
- Measuring articular passivity in order to diagnose cerebellar dominance **JO**
- Lower limb tapping **TA**
- While standing, slalom with a ball between obstacles using a foot **SL**⁷
- While sitting on a chair, rolling a ball on the track in the shape of the number eight between two points using a lower limb **RB**⁸
- While sitting on a chair, moving small cubes from place to place using a foot **CM**⁹

Final model from first version

Table 10

Fit of the 2-factor model performance tests 1. version of test battery without items HGR, CM and TW (adult population)

Model	Chi-square	P-value	df	CFI	TLI	RMSEA	SRMR
2-factor	21.48	0.078	13	0.98	0.97	0.055	0.032

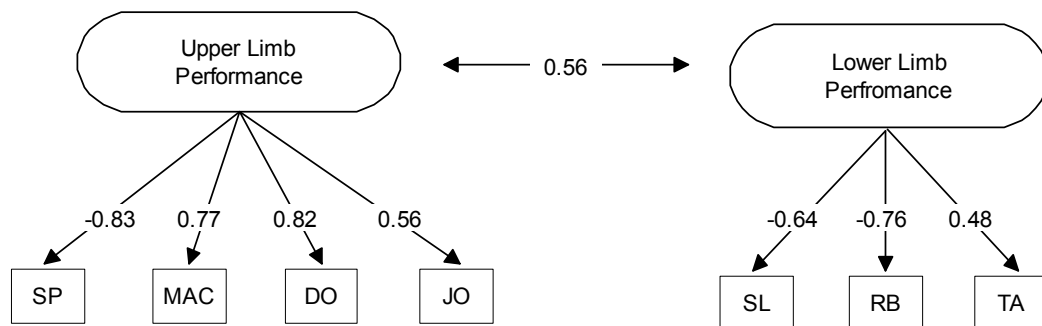


Fig. 5 Path diagram 2-factor model performance tests 1. version of test battery without items HGR, CM and TW (adult population)

This two-factor model without the HGR, CM, and TW indicators, which showed a further slight improvement in the model fit and signification, was finally determined as the most appropriate model in the first version of the test battery.

^{7, 8, 9} Time is not a constant in these tests, so the factor loading indicates a negative value.

Table 11*Generic reliability – performance tests 1. version (adult population)*

Name of the factor	McDonald ω
Upper Limb Performance	0.83
Lower Limb Performance	0.66

An interesting result in this part of the first version of the test battery is that the model fit and its significance are lower than in the models in the previous two parts of the test battery. This is probably due to the size of factor loadings of the indicators in the “Lower Limb Performance” factor, in which an unacceptable value of generic reliability (McDonald $\omega = 0.66$) has been found.

Performance test items from the second version of the test battery:

- Tracing the spiral: **SP**¹⁰
- Dot-filling fine motor test: **DO**
- Pegboard test: **PG**
- Threading beads on a metal wire: **STB**
- Collecting toothpicks (matches): **PT**
- Measuring articular passivity in order to diagnose cerebellar dominance: **JO**
- Lower limb tapping: **TA**
- While standing, slalom with a ball between obstacles: **SL**¹¹
- While sitting on a chair, moving a cube in the “maze” provided: **MF**¹²
- While sitting on a chair, taking off a knitted sock from one foot using the other foot:
TDS¹³

^{10, 11, 12, 13} Time is not a constant in these tests, so the factor loadings indicates a negative values.

Table 12

Fit of the 2-factor model performance tests 2. version of test battery without items PT, TDS and PG (adult population)

Model	Chi-square	P-value	df	CFI	TLI	RMSEA	SRMR
2-factor	14.13	0.36	13	0.99	0.99	0.021	0.032

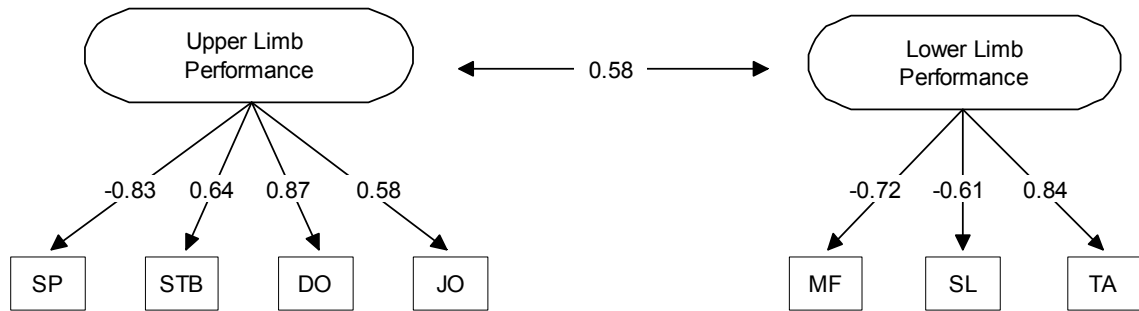


Fig. 6 Path diagram 2-factor model performance tests 2. version of test battery without items PT, TDS and PG (adult population)

The signification of the model P – the value of 0.36 – was also considerable. Therefore, this two-factor model without the PT, TDS, and PG tests was chosen as the best.

Table 13

Generic reliability – performance tests 2. version (adult population)

Name of the factor	McDonald ω
Upper Limb Performance	0.82
Lower Limb Performance	0.78

Summary:

In order to diagnose motor manifestations of laterality using performance tests the two-factor model, obtained from the second version of the test battery, was adopted. This model displayed a very good fit with a high diagnostic quality with two different factors. The final form of the adopted model of the performance test part contained

seven performance indicators. They were fine motor tests, gross motor tests, and an indicator determining articular passivity. The correlation between the two factors is at $r = 0.58$, which is a very similar result as in the performance test part in the first version of the test battery. In the second version of the test battery, it is also clear that human motor organ performance consists of two clearly distinct dimensions: “Upper Limb Performance” and “Lower Limb Performance”. These findings in both versions of the test battery with some different indicators support the hypothesis of different motor control and control of the upper and lower limb motion in relation to their functional nature in human life.

The SP and DO indicators, as in fine motor tests, displayed a close relation to the factor “Upper Limb Performance”. A weaker factor validity was shown by the STB test (Moving beads), $STB = 0.64$. Although this test was sensitive in distinguishing differences in the performance of both upper limbs, it also exhibited considerable variability, which could be caused by a covariance variable in the form of the amount of sweat on fingers when handling the beads. The last indicator in the “Upper Limb Performance” factor was the JO test (Measuring articular passivity in the wrist). The JO test had the weakest factor validity in this factor, but, with respect to the nature of this test, it was understandable. By contrast, a very interesting finding was that the JO indicator retained an almost unchanged factor loading, $JO = 0.58$, also in the second version of the test battery. This fact suggests a relationship between motor manifestations of laterality and cerebellar dominance. In the “Lower Limb Performance” factor, which includes three tests, the TA test (Lower limb tapping), $TA = 0.84$, was the strongest indicator. As opposed to the modelling in the first part of the test battery, this was a new finding. The different strength of the relationship of the TA test in both versions could be caused by errors in the calculations of the examiner. According to the study by Fremelová & Blahutková (2004), this indicator should have a strong relationship with the lower limb performance attribute. The remaining two tests of the “Lower Limb Performance” factor, MF (While sitting on a chair, moving a cube in the “maze” provided) and SL (While standing, slalom with a ball between obstacles), had a nature of manipulative activity, and, therefore, both of these indicators showed similar factor loadings. A stronger relationship of the MF test ($MF = -0.72$) to this factor could be caused by the fact that this test was carried out while sitting. Both lower limbs were relaxed, and only one of them worked in the activity itself. In the SL test ($SL = -0.61$),

which was performed while standing, one lower limb had a leading function – handling the ball, and the other lower limb had a supportive function – ensuring stability. The activity thus involved the co-operation of both lower limbs. In the test, this could result in affecting the outcome, in terms of different capability of stability of each lower limb.

TEST BATTERY FOR CHILD POPULATION:

a) Preference tasks

The data in this part of the test battery is of a categorical nature, and it is scored dichotomously. Indicators were also used where the activity in motor tasks is repeated several times. The WLSMV method was used as a parameter estimation.

The ontogeny of children's motor skills is different in upper and lower limbs. Lower limbs are lateralized later in children. Therefore, it was decided to use the two-factor model:

1. "Upper Limb Preference",
2. "Lower Limb Preference".

The motor task "Use the tube to look at the object. **LT**", which is included in both versions of the test battery, was not used in the structural equation modelling method. In order to express the relationship between this indicator and motor manifestations of laterality, the LT indicator was correlated, using tetrachoric correlations, with the final indicators that formed the most suitable preference task model for the test battery designed for the child population.

Preference task items from the first version of the test battery:

- Draw a leaf according to the model. **DM**
- Take the bell in one hand and ring it. **RI**
- Take the ball in one hand and throw it at the target. **THR**
- According to the instructions, turn the cards of the given colours placed on the sheet of paper. **CAB¹⁴**
- Create a line in the marked space using matches. **MAR¹⁵**
- Show how many points you can roll with the dice on three attempts. **CTH**

^{14, 14} These tasks can be performed across the natural body axis of the individual

- Demonstrate how you brush your teeth. **TC**
- Open the box. **OPB**
- Kick the ball placed on the floor at the target. **KB**
- Using one foot, tap the rhythm that I am clapping. **TR**
- While standing, demonstrate how you slide without the support of your hands. **SLI**
- Stretch your arms sideways and make a 360-degree turn around your axis. **TU**
- Move the cube along the line on the floor using one of your feet. **CM**

Use the tube to look at the object. **LT**

Final model from first version

Table 14

Fit of the 2-factor model preference tasks 1. version of test battery without items TC, DM, CM and OPB (child population)

Model	Chi-square	P-value	df	CFI	TLI	RMSEA	WRMR
2-factor	26.71	0.22	26	0.99	0.99	0.034	0.534

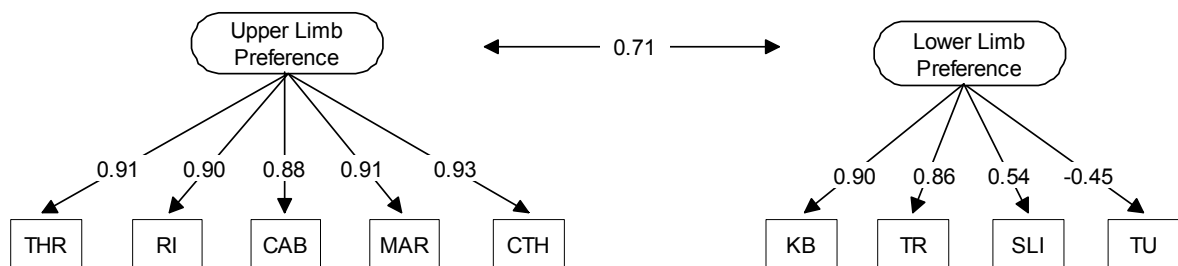


Fig. 7 Path diagram 2-factor model preference tasks 1. version of test battery without items TC, DM, CM and OPB (child population)

This two-factor structure with nine motor indicators finally proved to be the most appropriate in this first version of the test battery including the value of the P-value, which was at an acceptable level of P-value = 0.22.

Preference task items from the second version of the test battery:

- Draw a leaf according to the model. **DM**
- Take the bell in one hand and ring it. **RI**
- Take the ball in one hand and throw it at the target. **THR**
- Erase the line. **ER**
- Show me the following objects using one hand. **PO**
- Demonstrate how you stir with a teaspoon in a cup. **SBS**
- Press number 5 on the calculator. **CAL**
- Show me how you comb your hair. **CH**
- Kick the ball placed on the floor at the target. **KB**
- Show me jumps forward on one leg. **HOP**
- Start running and make a long jump. **LJ**
- Demonstrate how you would write the letter T on the floor using one of your feet. **WT**
- Step on the platform. **GOS**

Use the tube to look at the object. **LT**

Final model from second version:

Table 15

Fit of the 1-factor model preference tasks 2. version of test battery without items THR, DM, ER, SBS, CAL, WT and LJ (child population)

Model	Chi-square	P-value	df	CFI	TLI	RMSEA	WRMR
1-factor	30.90	0.0057	14	0.96	0.95	0.078	0.883

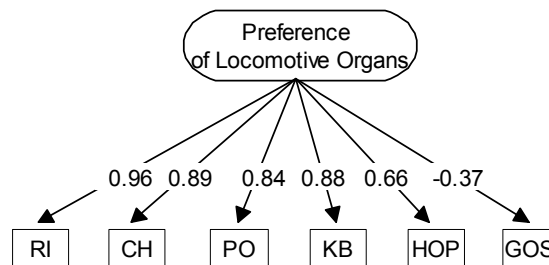


Fig. 8 Path diagram 1-factor model preference tasks 2. version of test battery without items THR, DM, ER, SBS, CAL, WT and LJ (child population)

The quality of the model was not acceptable. In particular, the RMSEA index (RMSEA = 0.078) only displayed an average value, and the same applied to WRMW (WRMW = 0.883). Furthermore, this proposed one-factor structure was below the chosen level of the model signification, 0.05, and the P-value was in this case only 0.0057. We assume that this model is too restrictive for quality assessing preference.

Although the value of generic reliability reached an acceptable level (table 16), this model was for previous reasons rejected.

Table 16

Generic reliability – preference tasks 2. version (child population)

Name of the factor	McDonald ω
Preference of Locomotive Organs	0.88

The relationship between eyedness and preference tasks assessing upper and lower limb preference:

Along with motor tasks assessing motor organ preference, ocular dominance was determined in both versions of the test batteries using the LT indicator (Use the tube to look at the object.). We thus correlated the LT indicator (Use the tube to look at the object.) with the individual preference tasks included in the adopted two-factor model from the first version of the test battery.

- Take the ball in one hand and throw it at the target. **THR**
- Take the bell in one hand and ring it. **RI**
- According to the instructions, turn the cards of the given colours placed on the sheet of paper. **CAB**¹⁶
- Create a line in the marked space using matches. **MAR**¹⁷

^{16, 16} These tasks can be performed across the natural body axis of the individual

- Show how many points you can roll with the dice on three attempts. **CTH**
- Kick the ball placed on the floor at the target. **KB**
- Using one foot, tap the rhythm that I am clapping. **TR**
- Stretch your arms sideways and make a 360-degree turn around your axis. **TU**
- While standing, demonstrate how you slide without the support of your hands. **SLI**

Table 17

Correlation matrix hand preference tasks and eye dominance (children population)

	THR	RI	CAB	MAR	CTH
THR					
RI	0.868				
CAB	0.896	0.859			
MAR	0.822	0.795	0.831		
CTH	0.718	0.897	0.824	0.850	
KB	0.654	0.629	0.703	0.575	0.669
TR	0.635	0.594	0.623	0.636	0.683
TU	-0.205	-0.108	-0.253	-0.219	-0.278
SLI	0.318	0.328	0.295	0.436	0.335
LT	0.313*	0.280*	0.224	0.336**	0.246

CORRELATION MATRIX (WITH VARIANCES ON THE DIAGONAL)					
	KB	TR	TU	SLI	LT
TR	0.810				
TU	-0.258	-0.330			
SLI	0.153	0.573	0.010		
LT	0.373**	0.482**	-0.181	0.109	

*significance correlation $p < 0.05$

** significance correlation $p < 0.01$

The correlation matrix shows that the LT indicator that determines the ocular dominance factor, through the sighting factor, significantly correlates with a total of three motor tasks assessing upper limb preference and two motor tasks assessing lower limb preference. Three of these motor tasks even displayed a significant correlation $p < 0.01$. However, the results show that a stronger relationship is observed between the LT indicator and motor tasks assessing lower limb preference, just as in the correlation matrix for the adult population. The KB (Kick the ball placed on the floor at the target) and TR (Using one foot, tap the rhythm that I am clapping) indicators showed a significant correlation with the LT indicator at the significance level of $p < 0.01$.

Summary:

The final form of the preference motor task part for the child population is composed of a two-factor structure with nine indicators from the first version of the test battery. This structure met all requirements of the diagnostic quality of an acceptable model. The results show that the indicators in the “Upper Limb Preference” factor, where the subjects worked across the natural body axis, CAB (According to the instructions, turn the cards of the given colours placed on the sheet of paper.) and MAR (Create a line in the marked space using matches.) very well indicated the strength of the upper limb preferences. The “Upper Limb Preference” factor also contains three different motor indicators:

- the THR indicator (Throw the ball at the target.), involving both proximal and distal parts of the upper limb in movement,
- the RI indicator (Ring the bell.), involving mainly the distal part of the upper limb in movement,
- the CTH indicator (Show how many points you can roll with the dice on three attempts.), which is a combination of the movements of the two previous motor tasks.

The “Lower Limb Preference” factor contains four indicators. A very strong relationship with this factor was found in the motor tasks KB (Kick the ball at the target.) and TR (Using one foot, tap the rhythm that I am clapping.). While the KB task is a traditional motor task involving both lower limbs in the activity (one has a control function – kicking; the other has a stabilizing function), the TR indicator is designed to allow the subject to have both lower limbs relaxed. This condition is fulfilled by the fact that the subject is sitting on a chair while performing this motor task. The other two indicators, SLI (While standing, demonstrate how you slide without the support of your hands) and TU (Stretch your arms sideways and make a 360-degree turn around your axis), are more related to the assessment of the rotation attribute. However, recent studies show that there is a significant relationship between lower limb preference and rotation (Mohr, Landis, Bracha, & Brugger, 2003; Štochl & Croudace, 2012, in press). In performing these tasks, lower limb preference is assessed indirectly.

b) Performance tests

The data in this part of the test battery are of an interval nature. Both versions of the proposed performance tests contained tests with the reverse scoring character. These were the tests in which time was not a constant.

Performance test items from the first version of the test battery:

- Tracing the spiral **SP**¹⁸
- Moving beads from one box into another using tweezers **TW**
- Dot-filling fine motor test **DO**
- Measuring articular passivity in order to diagnose cerebellar dominance **JO**
- Moving matches using a hand **PM**
- Threading beads on a metal wire **STB**
- Turning a box alternately with the front and the rear side on the table **BTW**
- Lower limb tapping **TA**
- Slalom with a ball between obstacles **SL**¹⁹
- Kicking a ball against the wall **RKB**

In the performance test part, the two-factor model was first tested. Conceptually, this model was based on the theory that, viewed functionally, upper and lower limbs are controlled differently. In addition, it was assumed for the child population that the lower limb would not display such a degree of lateralization due to its slower motor ontogeny.

Factors:

- “Upper Limb Performance”,
- “Lower Limb Performance”.

With respect to the fact that our data met the condition of multivariate normality, we used the maximum likelihood (ML) method as a parameter estimation.

¹⁸ Time is not a constant in this test, so the factor loading indicates a negative value

¹⁹ Time is not a constant in this test, so the factor loading indicates a negative value

Final model from first version

Table 18

Fit of the 1-factor model performance tests 1. version of test battery without tests PM, SL, RKB and STB (child population)

Model	Chi-square	P-value	df	CFI	TLI	RMSEA	SRMR
1-factor	5.57	0.78	9	0.99	0.99	0.004	0.021

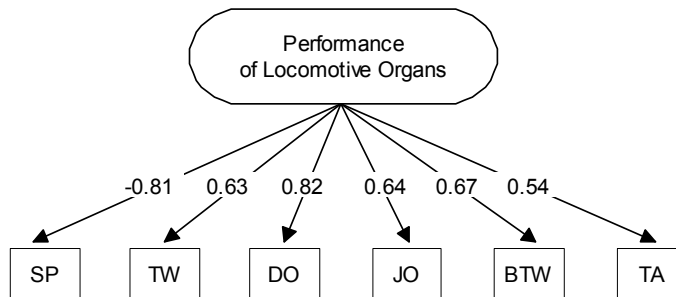


Fig. 9 Path diagram 1-factor model performance tests 1. version of test battery without tests PM, SL, RKB and STB (child population)

Table 19

Generic reliability – performance testss 1. version (child population)

Name of the factor	McDonald ω
Performance of Locomotive Organs	0.83

This one-factor model with six motor tests in the first version of the test battery met all the conditions of the acceptable model. The values of all fit indices showed a very good fit, including high model significance, P-value = 0.78.

Performance test items test in the second version of the test battery:

- tracing the spiral **SP**²⁰
- dot-filling fine motor test **DO**
- screwing a nut on a bolt **SCN**²¹

²⁰, Time is not a constant in these tests, so the factor loadings indicates a negative values.

- pegboard **PG**
- turning a card between fingers **TWC**
- measuring articular passivity in order to diagnose cerebellar dominance **JO**
- lower limb tapping **TA**
- slalom with a ball between obstacles **SL**²²
- while standing, moving a cube in the “maze” provided **MF**²³
- while sitting on a chair, moving small cubes from place to place using a foot **CM**²⁴

Final model from second version

Table 20

Fit of the 1-factor model performance tests 2. version of test battery without tests SCN, CM, MF and SL (child population)

Model	Chi-square	P-value	df	CFI	TLI	RMSEA	SRMR
1-factor	31.90	0.0002	9	0.94	0.91	0.108	0.041

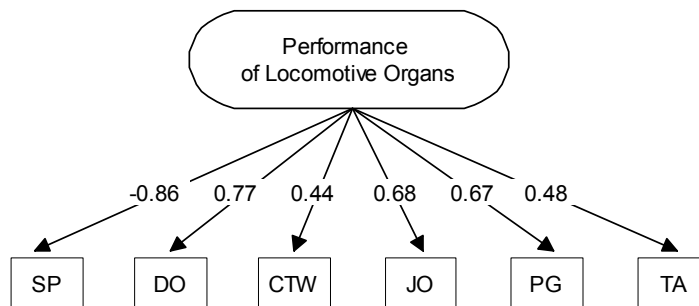


Fig. 10 Path diagram 1-factor model performance tests 2. version of test battery without tests SCN, CM, MF and SL (children population)

This one-factor structure with six indicators did not show satisfactory model fit values. All indices reached below-average values, including model significance. Despite

²¹⁻²⁴Time is not a constant in these tests, so the factor loadings indicates a negative values.

the fact that the quality of this model was low, the approximation of generic reliability (Tab.21) was the only one to meet the diagnostic quality with its value. However, this model was found unsatisfactory, also based on the results of the residual covariance matrix, which displayed high unexplained residuals; the model was therefore rejected.

Table 21

Generic reliability – performance tests 2. version (child population)

Name of the factor	McDonald ω
Performance of Locomotive Organs	0.81

Summary:

The model chosen as the best was the one-factor model of performance tests from the first version of the test battery, which met all requirements of diagnostic quality, including the acceptable level of the diagnostic error of the construct approximated by the coefficient McDonald $\omega = 0.83$.

The adopted one-factor structure of performance tests consists of six indicators. The motor tests SP (Tracing the spiral) and DO (Dot-filling fine motor test) are focused on fine motor activity involving mainly the distal part of the upper limb, i.e., hand and fingers. While the SP test emphasizes the rotational movements of the wrist to keep the firmest spiral line, the DO test is focused on controlled flexion and extension in the wrist with the requirements for targeting the tool in small space. The motor test TW (Moving beads from one box into another using tweezers) combines the activity of the distal and proximal parts of the upper limb, the more difficult part being the handling of the tweezers in the hand and grasping the bead. However, in addition to difficulties in grasping the bead with the non-preferred upper limb, an important phenomenon in this test was also the problem of estimating the distance when moving the beads from one box into another. A new approach to assessing the upper limb performance is represented by the BTW test (Turning a box alternately with the front and the rear side on the table), which involves the entire upper limb from the proximal to distal part, while the movement coming from the shoulder joint represents hand pronation and supination. When this test was being performed with the non-preferred limb, greater

accompanying movements of the preferred hand that were supposed to be passive were observed in children. The JO test (Measuring articular passivity in order to diagnose cerebellar dominance) was the last indicator related to upper limb performance. Surprisingly, the JO test did not display the weakest factor validity in this case. In both versions for the child population in diagnosing motor manifestations of laterality, the test exhibited a stable strength of the relationship to the “Preference of Locomotive Organs ” factor. This fact thus indicates the relationship between motor manifestations of laterality and cerebellar dominance (in the form of the physiological extinction syndrome), proposed by Professor Henner, also in the child population.

The only test that determines the different performance between the lower limbs was the TA test (Lower limb tapping), which displayed the weakest factor loading in the adopted one-factor model. However, given the functional differences of upper and lower limbs, this degree of relationship is understandable. Interestingly, this diversity was not as sharp in the child population as in the adult population. It was already found in the course of the testing that children are able to distinguish very well the preferred lower limb in preference motor tasks. However, the borders were blurred in the manipulative tests determining differences in dexterity between the preferred and non-preferred lower limb. Both lower limbs displayed the same unskilfulness. This fact could be explained by lower requirements concerning the stabilization of the lower limb lateralization in children that subsequently result in the stabilization of both preference and observable proficiency (fine motor activity) of the lower limb. This hypothesis was also supported by the results of analyses which showed that the tests focusing on finer activity of the lower limb or the foot alone showed instability, and thus were not appropriate for the child population.

CONCLUSION

The test battery for the adult population consists of three parts: a questionnaire, a preference motor task part, and a performance test part. The questionnaire part of the test battery has a unidimensional nature called “Preference of Locomotive Organs”. The strongest indicators were those of an instrumental nature. An interesting finding is that the frequently used indicator “which hand do you use to write” had to be removed in the modelling of the structure of this part, because it showed strong multicollinearity.

The preference motor task part has a two-factor structure with the factors “Upper Limb Preference” and “Lower Limb Preference”. The results of modelling in this part of the test battery show that in order to obtain a more precise picture of motor manifestations of laterality it is appropriate to include tasks exhibiting the nature of unskilled spontaneous activity, in addition to skilled instrumental motor tasks.

The performance tests have a two-factor structure with the factors “Upper Limb Performance” and “Lower Limb Performance”. This part of the test battery tested the relationship between the cerebellar dominance and hand performance, which was found to be statistically significant, reaching the level of $p < 0.001$.

The test battery for the child population consists of two parts: a preference motor task part and a performance test part.

The preference motor task part has a two-factor structure with the factors “Upper Limb Preference” and “Lower Limb Preference”. It was found that the factor “Upper Limb Preference” is closely related to “reaching tasks”, where the subject can repeatedly work across the natural body axis. The perspective of the advantages and disadvantages of handling an object across the natural body axis could be the main indicator of preference.

The performance tests have a one-factor structure with the “Performance of Locomotive Organs” factor. The results of this part of the battery display a different lateralization of upper and lower limbs. The tests focusing on lower limbs showed that the more significant fine-motor nature emphasizing balance a certain activity exhibited, the less sensitive the tests were. This part also tested the relationship between cerebellar dominance and hand performance; as in the adult population, this relationship was statistically significant, reaching the level of $p < 0.001$.

The diagnostic quality in the form of generic reliability in both test batteries range from 0.78 to 0.95.

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