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REVIEW ARTICLES

ABOUT THE MOTORITY STRUCTURE – AN ATTEMPT TO THE SYSTEM APPROACH

by

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Problems involved in human motority are very complex. Due to presence of numerous internal and external factors the existing attempts to classify them and develop the finitions and standards are fraught with serious difficulties. Moreover, the knowledge required for the studies of human motion comes from several fields and has to be adapted to the specificity of physical education domain. These branches of knowledge, relatively young exist on the borderline with other spheres, and do not always provide the precise theoretical basis. The researchers have to make their own choice, which may lead to difficulties while communicating not only with the specialists from other fields, but also with those involved in the same research. As an extreme example one can mention here the notion of "motor traits", widely used in Poland (attributing biological aspects to results of motor efficiency tests) or the concepts of "health — related fitness" and "performance related fitness" which appeared lately (mostly in USA). These problems will be discussed in more detail in further sections. Another important problem is the adequacy of testing, up till now identified with test reliability. Our communications may lead to many misunderstandings due to the absence of the reference system (so-called "golden standards") and incorrect treatment of results of motor fitness tests (often well-chosen intuitively), regarded as the measure of their biological foundations.

Actually, it is a complicated problem, as "population" tests are usually supplemented — in undefined degree — with motority skill tests. That leads to misuse of qualifications of biological terms "development" or "genetic conditioning" in relation to the results of fitness tests.

In the present work we shall introduce the general concepts proposed by the "Polish motority school", developed in 1988 — 1998 in academic centres of Cracow and Katowice.

These notions are based on biological foundations developed by a Polish scientist Z. Gilewicz (1964). We make a further attempt to use the developments in order to

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precisely define and systemise the notions on the scientific basis; as well as to work out the basis for checking the test validity. It is a well-established fact that every movement of a man is the effect of co-operation of biological basis (movement apparatus, energy sources, steering processes), of practical experiences (motor skills) and psychosocial environment (psyche, aims of movements, justification etc). The distinction between the motion potential side (to be able, to want, to know) and the effective side (movement process and its effects) also seems well founded. This first aspect is the domain of basic sciences, the second belongs to the field of physical education.

1. Potential side

The fundamental stage distinguished in proposed structure are **predispositions, understood as relatively elementary structural and functional traits of an organism in a significant extent determined genetically, which can be measured using the techniques of basic sciences.** In different combinations and in different degree they will determine the potential of human motion, so-called motor abilities. These will be discussed in more detail in the further sections.

Certain expressions call for further explanations. First of all, the expression "relatively elementary": in spite of theoretical possibility of determining the fundamental and theoretically existing possibilities of qualification of most elementary traits (also gene structure), in practice implies the necessity of analysing a large number of traits in laboratory conditions, using very expensive apparatus. Furthermore, the tradition in many fields of knowledge (e.g. physiology) provides more adequate though more complex measures in relation to their elementary components. Thus this stage will involve the features differing in a degree of being "elementary", such e.g. the response time, structure of muscle fibres or the effort heart rate. Some of thus defined "predispositions" (Szopa 1989, 1992, Szopa et.al. 1996, Szopa et.al. 1999), e.g. $VO_{2\ max}$, space orientation etc. will be transferred to the "higher" level of the structure, in consideration of their complexity (motor abilities). The expression "significant genetic determination" requires an explanation, too. It is well known that quantitative traits display various levels of genetic control (see Bouchard et.al 1997) — from very weak to comparatively strong. The word "significant" should therefore exclude the "traits" dependent on environmental conditions only – those having only external effect — while the list must not be restricted to the traits of strong genetic determination.

In the light of prevailing biological aspects, the predispositions can be categorised in four groups:

A) morphological — structural

These include the basic traits characterising the state of the motion system and these anatomical conditions which are major determinants of the motor efficiency. This is the groups where the genetic aspects are the strongest: length and width of

the skeleton, body proportions (especially of osseous lever mainspring), number of myons, proportion of muscles fast fibres to slow fibres (FT/ST), muscles innervating, flexibility. We can also include here the traits of weaker genetic control, such as fat mass (negative predisposition), lean body mass LBM — etc.

B) energetic

These include the measurable [as far as possible] traits characterising efficiency of mechanisms releasing the energy for muscles work, such as: the level of phosphocreatinum, efficiency of glycolytic enzymes, of Krebs cycle, of respiratory chain, main parameters of circulatory system (heart volume, number of erythrocytes, haemoglobin rate) and respiratory parameters.

C) senso-motoric — control

These are based on neuro-physiological mechanisms of motion control. The most important point is that the centres situated in different levels of central nervous system (association and motorial centres of cortex, basis ganglia etc.) should co-operate, thus we get a pyramid-like system. That includes all kinds of motor response (Tarnecki et.al 1991): inborn reactions (generated by hereditary neurones systems), acquired motor response (conditional on development of motorial programmes in CNS centres and the efficiency of interneuronal connections), and postural movements — dependent on functioning of central co-ordinating programmes integrating the activity of optical, tactile, kinestetic and equilibrium receptors and of motorial centres. Leaving aside the motion control stages identified by biocybernetics, (programme, realisation, correction), we assume the following to be the basic predispositions:

— quality of receptors functioning (eyesight, hearing, touch, equilibrium, kinestetic feeling),
— efficiency of starting the existing motorial programmes,
— ability of neurons to create new neural networks,
— nerve-muscle co-ordination,
— ability to create new motorial programmes (the efficiency of motorial centres of brain cortex).

Considering the present state of knowledge it is difficult — or even impossible — to directly measure the above-mentioned predispositions. Thus we are justified to resort to some available (or newly developed) psychomotor tests, which check:

— simple reaction time to optical, acoustic and tactile stimuli (co-ordination of receptors, centres and effectors within reflexive bows),
— complex reaction time (reaction to various stimuli expressed with different parts of body), also to moving objects,
— precision of movements (exactitude of movement),
— frequency of movements (the equilibrium of actuating and braking processes),
— rhythm of movements,

— rate of learning,
— accuracy of learning,
— persistence of learning.

D) psychological predispositions

These are involved in man's personality and as such are the subject of psychological studies. Without going into in details, we will signal only, that these include: temperament, motivation, will-power, intelligence — very important in attaining the definite motor results. Their "elementary" nature is questionable and complexity so considerable that they should be transferred to a higher level of the structure, that is motor abilities.

While discussing the predispositions, we must bear in mind that their importance manifest itself only during movement. It is obvious that every movement will require the predispositions from all of groups. However, depending on general characteristics of the type of movement (kind of muscular work, time of effort duration, intensity, complexity), and considering their common biological foundations we can group them in complexes called **"motor abilities"** (Szopa 1989, Szopa et.al 1996). This term and its range of application is a most controversial problem in kinesiology; since this notion is partly theoretical (Raczek 1990, Osiński 1990); while its complexity implies that it combines the potential and effective aspects of motion. No adequate tests for these abilities were available, (the former were called strength, speed, endurance and co-ordination abilities);

Important research work done in Poland in recent years, based on measurements of a large numbers (even 100) of primary parameters (predispositions), (Szopa and Latinek 1998, Szopa et.al. 1999) using the multidimensional statistical analysis (three stages factor analysis and taxonomic analysis) allowed to achieve the three main goals:

- Identifying the features most accurately characterising each group of predispositions (so called "golden standards"),
- Determining the interrelations between groups of predisposition, and thus also qualification of kinds and structures of motor abilities,
- Defining the methods and validity of testing the analysed abilities.

The immediate result, together with those obtained by the researchers from "Katowice school" (Mynarski 1998, Juras et.al 1998, Waśkiewicz et.al. 1998) was the ready definition of motor abilities, and the consequence — more distinct separation between the potential and effective aspects of motority and closer relations between motor abilities classification and their biological basis (thus the "complexity" was reduced).

We would propose the following definition:

"Motor abilities are groups of interrelated predispositions integrated by their common biological basis and movement backgrounds, measurable in a valid and comprehensive manner".

In the light of this definition the motorial aspect — being a utilisation of ability is partially transferred to effective side, which makes the structure more clear.

Basing on the above criteria as well as obtained results, we can distinguish at present at least 10 kinds of motor ability grouped in four complexes:

1. Strength abilities — understood as readiness of an organism to overcome the external or its own body resistance in movements at low speed and under considerable load.

a) ability of developing the maximal absolute static strength. It determine the possibilities of developing the maximum moment of strenght (absolute and relative) by all muscles. Since thus defined ability is in fact impossible to measure, we would recommend the measurements of maximal moments of strenght for the largest groups of extensors during stabilised, isometric contraction, in laboratory conditions.

The "medicine ball throw backwards" proved to be the most valid indirect test.

Main predispositions involved in these abilities are: transverse area of muscles, proportions of osseous lever mainspring, inervation of each myons and anaerobic sources of energy. This ability shows rather weak genetic control and is easily trainable.

b) ability of developing the maximum, local static strength. It defines man's possibility of developing the maximum moments of strenght in each muscle or groups of muscles (e.g. knee extensors, shoulder flexors etc). This means (which is borne out by results of several works), that "local strength" is relatively independent of the general strength factor and its specificity depends on sex: in women it is greater in lower limbs, while in men — in the upper. Predispositions and immediate measurement of this ability are identical as in the case of absolute strength, while the most valid indirect tests are dynamometric measurements or "arm bent hanging".

Recognising this ability as the separate factor may seem a bit surprising, it confirms the presence of both "general" and "specific" factors.

In case of features of weak genetic control this is of course possible, because the strength of muscle groups depends in a large degree on the environmental conditions.

2. Speed abilities — understood as the ability of the organism to utilise the **maximum of energy in the shortest time possible** (developing the greatest acceleration of the whole body or the body parts).

Three abilities can be distinguished in this group:

— **ability of developing the maximum alactacid anaerobic power MAP_A** determining the possibility of the human to release the energy stored in muscular phosphocreatine. It enables one to attain the maximum power in the shortest time possible thus being the basis for short efforts of maximal intensity. It is obvious that main predispositions will be the number of FT, ability of storing of phosphocreatine and the efficiency of energy release.

Measurement of this ability is yet controversial, as the problem of time required for obtaining the maximum power is still open to some discussion. Most authors maintain that it takes place between the 5th and 8th second of maximum effort, therefore the "Wingate Test" (Inbar et. al. 1976) and measurement of **magnitude** of the maximum power seem most adequate. The required [though lower] level of test validity is provided by indirect tests, such as Margaria and Georgescu tests, or measurements of the magnitude of maximal anaerobic work (MWA) calculated as the product of long jump or vertical jump results and the body mass (Szopa et. al. 1996). Genetic control over this ability is significant, its trainability is limited, these tests should than be taken into consideration while recruiting young men to competetive sport.

— **ability of developing the maximum lactacid anaerobic power MAP_L**, which defines efficiency of glycolytic processes (anaerobic glycolytic transformation). It provides the energy required during efforts of maximum intensity, lasting 40 sec on the average, and its main predispositions is again number of fast fibres and efficiency of glycolytic cycle. The recommended laboratory test is again the "Wingate Test" and measurement of the **total executed work**. Indirect measurement is difficult, because it should be the test of maximum intensity and time of duration about 30 sec (e.g. 200–300 m. run, 50 m. swimming etc.). We should bear in mind however, that the number of components that may impact the final results of such test is greater (including lactacid and alactacid MAP elements, acid-alkaline equilibrium of blood and $VO_{2\,max}$.). Thus it involves the measurement of "capacity" of anaerobic sources (anaerobic capacity), rather than of their power — results of these tests will not be expressed in the units of power, anyway. Genetic control over this ability appears relatively low, while trainability is considerable.

We wish to emphasise that "energetic abilities" have been recognised by physiologists of work for a long time already — including them in our "set" is simply the confirmation of well-known facts and integration of motority theory into basic sciences.

— **ability of fast muscle mobilisation**.

This ability is most difficult to identify, because it involves energetic and coordination predisposition thus making it most complex, as the straight reference to biomechanical parameters of muscles work (e.g. speed of developing of maximum power) does not seem adequate. It is a most complicated property of the organism providing for quick stimulation of large numbers of myons (inervation, activity of steering centres) but also for brake application and energy release. Laboratory measurement of this ability **could be time at achievement of maximum power during Wingate Test or isometric contraction** in conditions of effort repeatability. Most adequate indirect tests are "envelope run" and "shuttle — run 10 × 5 m", genetic conditioning is rather strong — and trainability is moderate (Szopa and Prus 1997, Prus and Szopa 1997).

3. Endurance abilities defining the **possibilities of organism to execute prolonged muscular work without signs of fatigue in efforts of submaximal inten-**

sity. Including effectiveness of the systems of circulation and respiration — corresponding to "cardio — respiratory — endurance", as it is the English term. Two distinct factors should be considered:

— ability of maximum oxygen uptake ($VO_{2\,max}$).

It determines the efficiency of mechanisms of oxygen utilisation in muscles.

The number of predispositions involved in these abilities is exceptionally large: parameters of heart work, the composition of blood (number of erythrocytes, quantity of Hb), number of mitochondria, efficiency of Krebs Cycle enzymatic systems and of respiratory chain, efficiency of respiratory system etc. The most important factor here is doubtless the respiratory chain (substrate oxidation).

The only reliable measuring techniques here are immediate measurements based on the analysis of gases breathed in and out (O_2/CO_2) in the condition of gradual effort lasting "till refusal" (descriptions in every physiology book). All indirect methods (long time cyclo-ergometric tests, Astrand Test whether Margaria Test) have only indicatory character and – if based on regression lines or on population material may involve considerable error in individual estimation. Our investigations reveal (Chwała 1997, Szopa et.al. 1999) that the **Cooper's tests is most adequate** . Genetic control over this abilities is weak while the trainability is subject to individual variations (Bouchard et.al.1997).

For lucidity of the discourse we have to remind that the ability of maximum oxygen consumption is the measure of "power" of oxygenic processes (aerobic power), not their "capacities" (aerobic capacity), which manifests as the ability for prolonged work. It involves mostly the second ability identified here, that is the **ability of muscle resistance to fatigue.**

On one hand it is based on the structure of muscle fibres (superiority of fibres ST), on the other — on mechanisms of acid — alkaline equilibrium — and on psychical traits.

Test or the decrease of maximum strength during isometric contraction. Most valid indirect tests are "arm bent hanging" and "sit-ups".

As it can be seen, these strength and endurance abilities display two — factors structure, while speed abilities involve three factors.

It seems that those 7 motor abilities mentioned here having the structural — energetic background can be somehow related to "conditional — abilities", however it can be only clearly specified how these should be tested using scientific methods (this problem was partly identified by physiologists). These abilities must not be regarded as quite separate groups, because they can often involve the same predispositions, though in different proportions. It would be difficult to determine the strength of genetic control over this abilities, because such studies have not been conducted till now.

The above list of abilities supplement the list of those with entirely different backgrounds (functioning of CNS and of organs of sense) completes the list. These are the following:

4. Co-ordination abilities, understood as the ability of an individual to perform an accurate, precise movement in changing external conditions.

According to the latest works (Juras et.al. 1998, Waśkiewicz et.al. 1998, Szopa and Latinek 1998) they involve the following:

— **ability of space orientation,** understood as co-operation of receptors and nervous centres responsible for quick and exact reaction to changes in body position or body parts position in space or in relation to other objects. The predispositions here are: sensibility of receptors (optical, acoustic, tactile, equilibrium, kinestetic feeling) and speed of starting the existing motorial programmes by motorial centres. It is however very difficult to point out any adequate tests allowing for precise measurements of this ability; those used till now (cross-shaped apparatus, computer tests WCS etc.) measure rather predispositions (Juras and Waśkiewicz 1998), while population tests (see Mekota and Blahuš 1983) do not fulfil the validity criteria. It seems that at present the research should be restricted to investigations of predisposition, at the same time working towards the development of adequate measurement tools. Genetic control some of them seems to be rather strong (Szopa et.al. 1985); trainability is rather limited – so it should be the element in recruitment tests for competetive sport.

— **Ability of motor adaptation,** understood as relatively generalised and fixed condition to provide for advisable programming, corrections or also reconstruction of motorial activity adapt to constantly changing and not foreseen situations, involving also the reaction of an individual while directly faced by an adversary. Apart from indispensable receptors, this ability involves the compilation of **the elements of control, finding and starting definite motorial programmes** — (e.g. fields 2, 4, 6 in motorial cortex, lateral cerebellum areas).

We have to bear in mind, however, that this definition is rather general — it must be so because otherwise we would have to define separate predispositions as abilities. In this case the predispositions are: the quality of motorial programmes and steering centres, number of interneuronal connections, depth of vision, anticipation (completely acquired and learnt), etc.

No synthetic tests checking this ability is available now — it is doubtful anyway whether such tests could be developed. For research purposes we recommend testing the predispositions and running the tests of complex motor reactions in laboratory conditions.

As far as the motor adaptation ability is concerned, there are no data on genetic control. Judging however by results of research work concerning predispositions (Szopa and Jaworski 1998), the genetic conditionings is rather weak while trainability is considerable.

— **Ability of movement learning** (movement capabilities)

That means speed, exactitude and persistence of learning new movements, however not in qualitative, but quantitative terms. A distinct feature of this ability is that it involves the **existing motorial programmes** in smaller degree, **while it relies mainly on their durability and correction**. Apart from specific CNS properties,

the predispositions here are: receptors functions, especially kinetics feeling, eyesight, hearing and efficiency of association centres of brain cortex with regards to the speed of motorial programmes correction. We are fully aware that in many human behaviours (including competetive sport) there is not enough time for learning during sports competitions -the ability of motor adaptation becomes the decisive factor. This ability has its roots partly in individual experience (often automated) — it is therefore the function of the whole movements control process, not only of its fragments. Definitely, it is an acquired ability.

As far as the possibilities of testing are concerned, the opinions tend to differ. Older tests were based on exercises well known to participants (being even the part of school curricula); moreover the evaluation was either subjective, or expressed in age categories (tests of: Johnsons, Johnsons — Metheny, Ozierecki's). They did not have definite validity — even intuitive. The results of our investigations (Szopa and Wątroba 1992, Szopa and Latinek 1998) show that one should use tests involving motion sequences, not learned or investigated before. Whether the measurement will be valid or whether the evaluation will be done by an experienced coach does not seem to be of any importance: e.g. standardised tests proposed Latinek (1995), have a high degree of correlation with subjective estimations.

Table 1. Motor abilities and their testing

Ability	Direct measurement	Indirect test
1. Developing of maximal, absolute static strength	Maximal strength torques of greatest muscles groups during isometric contraction	Medicine ball throw backward
2. Developing of maximal local strength	Maximal strength torques of particular muscles	Dynamometric measurement
3. Alactacid MAP	Wingate Test – maximal power	Standing broad jump (MAW)
4. Lactacid MAP	Wingate Test – work capacity (30 sec)	200–300 m run
5. Speed of muscles mobilisation	Time of developing of maximal strength (power) during isometric contraction or Wingate Test	„Envelope" run 10 x 5 m run
6. Maximal oxygen uptake	Standard physiological tests	Cooper's Test, Astrand Test, Margaria Test
7. Muscles resistance to tiredness	Power or strength decrease during Wingate Test or isometric contraction	Bent arm hanging, Sit – ups
8. Space orientation	Analytic tests of predispositions	?
9. Motor adaptation	Analytic tests of predispositions	?
10. Movement learning	Speed, accuracy and consistence of learning of new movements	Coach observation

Motorial capabilities, as correlated with non — verbal intelligence, seem to be strongly determined genetically – therefore these should be considered while recruiting young people to sport – it is still more important that these are the basis for acquiring motor skills.

Summing up, one can ascertain, that the "list" of motor abilities includes 10 types of abilities – all of them should be the subject of rigorous research. These abilities are summarised in table 1.

In the light of these considerations, the problem of possible existence so-called "co-ordination" or else of "sports- talent" would arise. Though intuitively we would opt for its existence, yet it seems that this notion should encompass all potential aspects, particularly the co-ordination skills.

The last "element" involved in the potential side are **motor skills**. Though they are based on motor capabilities (involving the ability of learning) and acquired abilities (with no genetic background) – they are internalised (relatively permanent movement programmes in CNS) so we count them among potential aspects on the same level with motor abilities, as shown in the diagram below.

Testing motor skills is the most difficult problem , as it is necessary to apply a separate tests for each ability while the estimation involves comparing the activity with the reference pattern. Unfortunately, these patterns are seldom stable (e.g. sports), sometimes not easy to qualify (e.g. the style of individual champions): in such case objective measurement is difficult and should — in our opinion — be referred to some sort of a "standard style' based on the estimation movement efficiency i.e. its agreement with intentional aim, and not on the course of the activity (e.g. repeatability or movement precision). While evaluating motor skills we have to bear in mind that the required level might be obtained provided the already existing level of motor abilities is adequate, which is difficult to recognise during measurements.

In the light of these considerations, we can easily state that the effective aspects will involve the effects of man's motor activities, thus they would mean the manifestation of potential side (abilities and skills) in concrete human movements or motor activities. That is called **"motor fitness"**, being the individual feature. That means this, that an individual can have very good results in tests based on endurance abilities, and weak results in speed abilities tests etc. (which is a rule in most competitive sports). The results must not be therefore added up or averaged, since the averaged results (sometimes referred to as general fitness) make an "empty set" and do not give any information about the structure of fitness of an individual..

As far as the techniques for motor efficiency testing are concerned, we can distinguish two methodological approaches:

The first is investigation of different effects of motor activity only, e.g. in view individual fitness for the given profession or sport, or the usage of battery of tests qualifying the level of each motor ability, thus defining the motor "potential" of an individual.

The second approach may involve certain errors due to testing abilities by means of skills, yet it appears to be inevitable in populational studies. We would, therefore, recommend, this type of testing, provided those are duly verified for their validity. In hitherto existing test batteries (ICSPFT, "Eurofit" etc.) the validity was often confused with test repeatability, which resulted in a free choice in selection of tests. As the best example one can mention here "dimensions" and "factors" of motority proposed by "Eurofit" Authors (1988). "Dimensions" included speed, flexibility and equilibrium (!), while "factors" are e.g. functional strength, trunk strength, static strength, functional strenght (which strength is not functional?). Why trunk strength should be a factor, while that of lower limbs — should not? The "agility run" is a test, not a factor, but "agility" is not recognised as a motor ability — it was not confirmed by any analysis! Explosive strength should belong to speed abilities (alactacid MAP and speed of muscles mobilisation), speed of movements and flexibility are predispositions, and not factors (abilities) etc.

The notion **"physical fitness"** we understand in a broader meaning, as ability and skills of man allowing the execution of various motorial acts. This is the commandos or pentathlon sportsman's fitness, rather than that of a marathon runner. The latter last has only high motor fitness based on endurance abilities.

Estimation of motor fitness and physical fitness is additionally complicated by the fact, that apart from co-ordination ability, the results of tests are in large degree dependent on somatic parameters not only in progressive period, but also after its end. Apart from competitive sports where only results count, such estimation must take into account these relations making the results relative (removing the influence of development advancement) at least in categories of morphological age — not calendar years, so that it could be used for comparison between individuals. It is of primary importance while evaluating school children and in classification of children for sports. Such standards were developed in Poland in 1934 by J. Mydlarski; this work was continued at the Warsaw centre (Trześniowski 1964) and Cracow centres — (Żak 1991, Szopa et.al. 1996.

The last problem we have to discuss is the idea of dividing physical efficiency into "health — related fitness" (HRF) and "performance - related fitness" (PRF); this idea has become increasingly popular in recent years. The first of them relates fitness to health is very convenient, since the researchers (and also politicians and financial centres) will focus on health in its wider meaning. **It is a beautiful and useful idea, however is it well-founded and justified?** Is its scope and relation to PRF defined correctly? We shall present below the main critical points, at the same time we will propose a different approach — already presented in this paper . In our opinion it is more lucid, consistent and logical.

Let us start, however, with critical remarks:

1. Though the sense of adopting the HRF does not give rise to any doubts (at least in this sense- the state of internal organs and quality of metabolic processes are doubtless connected with health), its components are questionable (Bouchard

and Sheppard 1994, Bouchard et. al. 1997). These are those most frequently pointed out:

— morphological components and composition of the body, adipose tissue and its distribution, bone density, flexibility,
— muscular components: power, strength, endurance (?)
— motor components (?): agility, co-ordination, equilibrium, speed of movements,
— cardio-respiratory components-: aerobic capacity, efficiency of hearts, lungs, blood pressure
— metabolic components: tolerance of glucose, sensibility to insulin, lipids metabolism, characteristics (?) of substrate oxidation.

The list of components is by no means complete; in other works the list is limited, too (Wuest and Bucher 1991, Skinner and Oja 1994,). It involves the build and functions of the organism as related to motion. However is it really full and valid ?

Let us take a better look:

— among morphological components such an important feature as muscle structure and inervation, efficiency of nervous system etc are missing
— strength, power, endurance are not muscular **components** — this are **effects** of muscular work. "Components" are muscles structure, their inervation and blood supply, ability of quick contraction, of developing maximum strength, resistance to fatigue etc. Strength, power and endurance are physical concepts, having their definitions and units (power — W, strength — N, endurance — of what?) — We must not use the definitions taken from the basic sciences changing their meaning!
— the list of metabolic components is not full: why do we consider the characteristics of substrate oxidation, at the same leaving out the analogous ones for glikolisis, alactacid MAP, acid — alkaline equilibrium — etc?
— Why "sensibility to insulin", and not "sensibility to adrenaline", tyroxini etc?
— motor components involve motorial effects, not the state of an organism! Agility as a trait (ability) does not exist, co-ordination means whole processes of movement control, equilibrium and speed of movements are effects of working of CNS and of organs of sense.

It can be seen, that classification this is inconsistent, incomplete, including the elements of different origin and different level of generality. The majority of listed components are predispositions or motor abilities: this approach we introduced in the first parts of the present study.

2. The problem of testing HRF. In most proposal such tests have to be — at least partly — tests of motor fitness. Docherty (1996) and Osiński (1998) emphasise that causes that borders between HRF and PRF, get confused, which is the consequence of the absence of an adequate theoretical doctrine and of the main intention. These tests are not sufficiently valid (in relation to HRF), as they involve a number of motor skills.

3. Bringing PRF only to securing sport success (test results or sports results) would have some point, if one did not mix them with abilities already related to HRF (e.g. agility, functional strength, speed, endurance).

Summing up. it appears that the idea of HRF was developed for utilitarian, not for scientific purposes. In our opinion the comprehensive approach suggested here is much more valuable as it clearly distinguishes the **potential side (just HRF) from the effective one (PRF).**

REFERENCES

Bouchard C., Malina R.M., Perusse L. 1997. *Genetics of physical fitness and motor performance.* Hum. Kinet. Publish., Champaign, Ill.

Bouchard C., Shephard R. J. 1994. *Physical activity, fitness, and health: the model and key concepts* (In:) Bouchard C., Shephard R. J., Stephens t. (eds.) Physical Activity, Fitness, and Health. Human Kinet. Publish., Champaign, Ill.

Chwała W. 1997. *Investigations on the structure of "energetic" motor abilities and validity of their testing.* Doct. Thesis, Ac. of Phys. Educ., Cracow. (In Polish).

Docherty D. 1996. *Field tests and test batteries.* (In:) Measurement in Pediatric Exercise Science. David Docherty (ed.) Hum. Kinet. Publish., Champaign, Ill.

Eurofit. 1988. *European Test of Physical Fitness.* Brussels.

Gilewicz Z. 1964. *Theory of physical education.* SiT Warszawa. (In Polish).

Inbar O., Dotan R., Bar-Or O. 1976. *Aerobic and anaerobic components of a 30-s supramaximal cycling test.* Med. Sci. Sports (Abstr), 8.

Juras G., Waśkiewicz Z., Raczek J. 1998. *Ability of space orientation: identification, inner structure and methods of testing.* Antropomotoryka, 17. (In Polish, Engl. Summ.).

Latinek K. 1995. *Investigations on the structure of co-ordinational abilities with special regards to motor capabilities.* Doct. Thesis, Ac. of Phys. Educ.., Cracow..(In Polish).

Mekota K., Blahuš P. 1983. *Motorickie testy w telesno wychowe a sportu.* ŠCTV Praha (In Czech).

Mydlarski J. 1934. *Physical fitness of youth in Poland.* Przegląd Fizjologii Ruchu, nr 1. (In Polish).

Mynarski W. 1998. *The variability of the inner structure of motor abilities in children and youth.* Antropomotoryka , 17.

Osiński W. 1990. *Remarks on the definitions and classification the basis concepts of human motority.* Antropomotoryka, 3. (In Polish).

Osiński W. 1998. *Tendency in creating of physical fitness tests in the frames of conception of "health-related-fitness".* Antropomotoryka , 17. (In Polish).

Prus G., Szopa J. 1997. *Adaptability of chosen motor abilities in boys between 12 and 15 years of age: results of "training – detraining – retraining" experiment.* Antropomotoryka, 16. (In Polish, Engl. Summ.).

Raczek J. 1990. *Really new and responsible conception of classification and structure of human motority?.* Antropomotoryka, 4. (In Polish, Engl. Summ.)

Skinner J.S., Oja P. 1994. *Laboratory and field tests for assesing health - related - fitness.* (In:) Physical Activity, Fitness and Health. Human Kinet. Publish. Champaign, 111.

Szopa J. 1989. *New conception of the motority structure.* Antropomotoryka, 1. (In Polish)

Szopa J. 1992. *Manual of anthropomotorics.* Ac. of Phys. Educ. Press, Cracow (In Polish).

Szopa J. Jaworski J. 1998. *Genetic and environmental conditionings of some somatic and motor predispositions in rural population of Żywiec Province (Poland).* Antropomotoryka, 18. (In Polish, Engl. Summ.)

Szopa J. Latinek K. 1998. *Study on the essency and structure of co-ordinational abilities.* Antropomotoryka, 17. (In Polish, Engl. Summ.)

Szopa J. Mleczko E. Cempla J. 1985. *Variability and genetic conditionings of fundamental psychomotor and physiological traits in city population aged 7–62.* Ac. of Phys. Educ. Press, Cracow (In Polish, Engl. Summ.)

Szopa J. Wątroba J. 1992. *Further studies on motoricity structure with a special regard to motor capabilities.* Antropomotoryka, 10.

Szopa J., Chwała W., Ruchlewicz T. 1999. *Investigations on the motority structure and validity of their testing.* Journal of Human Kinetics, 1.

Szopa J., Mleczko E., Żak S. 1996. *Backgrounds of kinesiology.* Pol. Sc. Ed. Warszawa–Kraków (In Polish).

Szopa J., Prus G. 1997. *Train ability of motor abilities in men between 62 and 65 years of age.* Antropomotoryka, 16. (In Polish, Engl. Summ.)

Tarnecki R., Zawadzki T., Kałużny P. 1991. *Neuronalne mechanizmy organizacji i koordynacji aktów ruchowych.* (W:) *Problemy biocybernetyki i inżynierii biomedycznej.* (Red.) M. Nałęcz. Biosystemy, t., 1, Wyd. Kom. i Łącz., Warszawa.

Trześniowski R. 1964. *Index of physical fitness of boys and girls at the age of 7–19 years.* Ac. of Phys. Educ. Press, Warsaw. (In Polish)

Waśkiewicz Z., Juras G., Raczek J. 1998. *From studies on motor adaptation.* Antropomotoryka, 17. (In Polish, Engl. Summ.)

Wuest D.A., Bucher C.A. 1991. *Foundations of physical education and Sport.* (In:) Exercises, Fitness and Health. Hum. Kinet. Publish. Champaign, I11.

Żak S. 1991. *Structural — energetic and co-ordinational abilities of children and youth from city population on the backgrounds of chosen somatic conditionings and movement activity.* Ac. of Phys. Educ. Press, Cracow. (In Polish, Engl. Summ.)