SELECTED PROBLEMS IN INTERNATIONAL TERMINOLOGY OF THE HUMAN MOVEMENT SCIENCE

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Abstract:

The authors discuss the problem of human movement science terminology and point out the fact that terminology is (together with the field of research, subject of research, methods and methodology) one of the basic epistemological assumptions of any scientific discipline. Building the abstract models of reality, which is the fundamental task of science, seems to be impossible without the proper terminology, because the words are the main building material of theoretical models. Here lies the great responsibility of scientists, especially the English-speaking ones because English is the most commonly used language in contemporary science, in order to avoid ambiguous words and use clear terminology. Unfortunately, the scientists often seem not to be aware of this problem, and consequently some terms used in the science of human movement seem to be used inconsistently. This phenomenon is especially dangerous in translation from one natural language into another, because an improperly used term becomes even more improper in the process of translation. Thus the authors distinguish between two types of linguistic problems - the intralingual and the interlingual ones. The authors show some obvious inconsistencies in the usage of basic movement science terminology. They discuss the notions of physical efficiency, endurance and exercise tolerance. At first the authors quote some definitions formulated by other authors and show their obvious inconsistencies. The main source of inconsistencies seems to be treating each of them separately, while in fact they form a coherent system. Thus the authors show at first the interdependencies of all these notions and turn to the basic physical roots to describe the terms properly and to build their coherent system. Taking the previously mentioned into consideration, such a system should consist of four notions: physical efficiency, endurance, exercise tolerance and post-exercise tolerance. They make up a logical system, combined with the basic laws of physics and firmly rooted in biological realities. Especially illustrative is the phenomenon of supercompensation, which creates a fundamental basis of every sport and recreational training. The authors discuss the notion of force and its *variants* used in human movement science terminology. In physics it is an axiom, thus it may be described only by its effects in the environment. The most popular description of force is the second Newtonian Law which shows the relation of force to mass and acceleration. However, there are also other descriptions of force (e.g. according to Hooke's law). Nevertheless, the attempts to relate the notion of force to mass and acceleration in each situation sometimes leads to paradoxes. Thus, the definitions of shear force, fast force and endurance force, commonly used in human movement science, seem to have no roots in physics. There is also no clear differentiation between the notions of *force* and *strength*. From the point of view of physics especially doubtful are the notions of *explosive strength*, *static strength*, *dynamic strength* or *starting strength*. From the point of view of physics some of the previously mentioned terms do not denote forces at all. The authors suggest two definitions of force, useful in human movement science and congruent with general physics; the first description is the one denoting *force* as a physical quantity and the other one denoting muscular force, that is, *strength* as a motor ability. Then the authors turn to the reaction time paradigm and point to the semantic and logical inconsistencies in the model (the difference between *reaction time* and *response time*). They suggest a consistent model of sensorimotor response scheme. After having discussed these problems, the authors suggest more precise definitions of some commonly used terms. They also point to the necessity of creating an international encyclopaedic dictionary of human movement science.

Key words: *human movement science, terminology, energy abilities, motor fitness, endurance, exercise tolerance, force, reaction time paradigm, translation*

Motto:
What is necessary is to call things by their right names
Confucius

Introduction

The motto comes from the dispute between the Master and his disciple, Tzu-Lu. The next words of Confucius were: "*If names be not correct, language is not in accordance with the truth of things. If language be not in accordance with the truth of things, affairs cannot be carried on to success*". (Hooker, 1996) Zbigniew Czajkowski expressed the same idea with words: *To look is not the same as to see, to see is not the same as to perceive. We perceive really – on a higher, conceptional-functional level – only what we know, understand well **and can give a name to**.* (2005, p. 38)

According to the outstanding American psycholinguist, Noam Chomsky, language plays two roles: the communicative one, enabling the transfer of information between the *sender* and the *receiver*, and the representative one, enabling the building of abstract, theoretical models of reality in the mind of the *receiver* (Kurcz, 1995; Lyons, 1998). However, the reality is too complicated to grasp and describe it as a whole, so the main task of science – each branch of it – is to construct simplified representations of reality, i.e. the models. And while the reality is made of facts, phenomena and processes, the models and science as a whole are made of words. Thus, it is the words that determine the quality and usefulness of science (Petryński, 2002). Hence, the very basis of each branch of science is its terminology, i.e. a specific technical version of language. It determines the way of projecting reality into the realm of models built by each branch of science.

In language, the words, being the basic building stuff of models, are connected with each other by means of grammar. It is also not only a simple intellectual tool which has to bring order into the otherwise chaotic world of words. Chomsky created the theory of transformational grammar (also called *generative grammar* and *transformational-generative grammar*) which, among other things protects the language from creating senseless sentences (Kurcz, 1995; Lyons, 1998). Moreover, language has to make accurate projections of reality – facts, phenomena and processes - into the abstract sphere of the human mind. However, accurate does not mean identical. According to Bolesław Turczyński, "*a well made model also has heuristic properties: it makes it possible to discover new facts and associations between facts, to formulate new hypotheses, to check them, etc.*" (2002, p. 282). This statement, along with the words of Confucius quoted previously (Hooker, 1996), unveils another function of language not listed by Chomsky and that is planning the future. Thus, in science the language is not only a passive tool of description, but it is also an active instrument for creating a model in particular and science in general. This phenomenon creates a basis for the functioning of theoretical sciences, e.g. mathematics, theoretical physics, theoretical chemistry, theoretical biology, etc. Unfortunately, human movement science is considered as *applied science*, thus nearly all scientific journals expect scientists to write *original experimental papers.* Consequently, the sciences under consideration, unlike other branches of science, have a strong, well developed *experimental leg* and a weak, miserable *theoretical leg.* It is now clear that this phenomenon seriously endangers further progress in human movement science. To avoid this danger it is absolutely necessary to create a strong, solid basis of this branch of science, and this means to create **proper terminology**.

1. Two types of linguistic problems in science

The scientists, researchers, teachers and coaches, engaged in teaching and researching in various branches of science, especially the young ones, often have problems with terminology. It is possible to distinguish the following two types of problems:

- intralingual, and
- interlingual.

Intralingual inconsistency occurs when a scientific description of a new fact, phenomenon or process is not congruent with the common vocabulary of a given language. An example of it may be the terms *action approach* and *motor approach*. Even educated people, who know the words *motor*, *action* and *approach*, are not able to understand the term *motor approach* or *action approach* using only dictionary knowledge. Thus, scientific terms should be as close to their daily meanings as possible. The example of ignoring this rule may be the notion of *affordance*, introduced by James J. Gibson, who described it as follows:

*The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to **afford** is found in the dictionary, but the noun **affordance** is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment.*

If a terrestrial surface is nearly horizontal (instead of slanted), nearly flat (instead of convex or concave), and sufficiently extended (relative to the size of the animal) and if its substance is rigid (relative to the weight of the animal), then the surface affords support.

Note that the four properties listed - horizontal, flat, extended, and rigid - would be physical properties of a surface if they were measured with the scales and standard units used in physics. As an affordance of support for a species of animal, however, they have to be measured relative to the animal. They are unique for that animal. They are not just abstract physical properties. (Gibson, 1979, p. 127)

The word *opportunity* contains nearly the same information matter as the term *affordance*, thus the existence of the latter is not necessary. Moreover, its creation in English evokes similar phenomena in other languages. At the first glance it is not obvious that the terms *affordance* and *opportunity* are in fact nearly identical. More strictly, the slight differences between the two terms (*affordance* is only a specific case of *opportunity*) do not justify the creation of a new term. It should be noted that the feature which Gibson regards as the main characteristic of the notion of *affordance* – uniqueness for a particular animal – is also distinctive for opportunity. A given circumstance may create an opportunity only for a person who is able to use it. In this respect it is unique for this person only and there exists no difference between the notions of *affordance* and *opportunity.*

Nevertheless, also in German two different terms exist: *Affordanz* and *Gelegenheit* (Hossner & Künzell, 2003). It has to be noted that the word *Affordanz* consists in fact of the English root and the German suffix, thus it is completely incoherent with the very soul of the German language. Consequently, German transformational grammar does not protect that language against building senseless sentences when using such foreign words. Another example of a specific semantic paradox is the term *dynamic strength*. The word *dynamic* comes from the Greek term *dynamikos*, i.e. *forceful*; thus *dynamic force* means in fact *forceful force*. Moreover, in contemporary language the term *dynamic* is commonly associated with movement or changeability rather than with force. Ancient Greeks did not know that movement is possible also without the influence of force, and we have learned that it is possible only from Isaac Newton. The usage of ancient words, otherwise very common in science, is dangerous, because their meaning and the image of reality created with them represent the level of knowledge of ancient scholars, and not contemporary scientists.

In translation rather serious things can happen if words are not translated correctly – this consequently means, that a good translation means finding an appropriate translation equivalent of a word in another language. The meaning of a word in one language is often not identical with the meaning of its equivalent in other languages. This is briefly and aptly expressed by the Italian proverb *traduttore*, *traditore* (*the translator is a traitor*). Hence, if some notion is not exactly or even incorrectly defined in one language, then such imperfection deepens due to improper translation. As a result, the scientific language becomes imprecise and not able to make a solid basis of science; such a phenomenon seriously endangers the development of science all over the world.

An example of another problem is the word *predisposition*. In the *Oxford Dictionary of Sports Science and Medicine* by Michael Kent one can find the following definition:

Predisposition - "*A tendency to be affected by a particular disease or injury. The predisposition* ***may be inherited or acquired****. Athletes who do not warm up prior to training have a predisposition to joint and muscle injuries.*" (Kent, 1995, p. 344)

And in the Polish language dictionary (Słownik języka polskiego) one can read:

Predyspozycja (predisposition) – "***Inborn*** *tendency to something, disposition, temperament*" (*Słownik języka polskiego*, 1990, vol. II, p. 917)

Here we have to do with the so called *false friends*, because although the word sounds very similar in different languages – and in fact has the same root - its meaning may not be exactly the same. Some minor divergences are tolerable in daily use, but in scientific language, which ought to be very precise, they make an important difference. For example, what the English word *predisposition* denotes may be either inherited or inborn, while in Polish *predyspozycja* refers only to something inborn.

Another example is the Russian term *повторения без повторений* (*repetitions without repetitions*). It has the English equivalent *equifinality*. Nevertheless, here exists some important difference: the Russian term denotes a process, whereas its English equivalent denotes a phenomenon (Bernstein, 1991; Latash & Turvey, 1996).

To overcome both the intra- and interlingual inconsistencies, it is absolutely necessary to create an international encyclopaedic dictionary of the science of human movement. Since in contemporary science the most commonly used language is English, it should have the role of a *lighthouse* or *point of reference*. Thus, extraordinary responsibility for purity and exactness of scientific language lies with the English-speaking scientists. Unfortunately, they do not seem to feel this responsibility.

2. Energy abilities: *the notions physical efficiency, endurance and exercise tolerance*

At first let us define three basic notions from the field of energy (effort) abilities: physical efficiency, endurance and effort tolerance.

According to Aleksander Ronikier:

Physical efficiency – "*Capacity of an organism to perform a maximum work with functional equilib-*

rium. It depends on the structure and development of an individual, efficiency of supplying systems, metabolism and mechanisms of thermoregulation" (2001, p. 12)

Jerzy A. Żołądź wrote:

Physical efficiency *means capacity of an organism to produce physical efforts; this notion includes also the tolerance of intrabodily homeostasis disturbances, evoked by physical effort, as well as the ability of the organism to their quick elimination after completing an effort.* (2002, p. 456)

According to Henryk Kuński:

Physical efficiency – "*Capacity of an organism to perform a maximum physical work in conditions of functional equilibrium; it depends on the structure and development of an organism, efficiency of cardiovascular and respiratory systems, metabolism and thermoregulation. Concise measure of the physical efficiency is the amount of oxygen consumed by muscles*" (2002, p. 196).

All the quoted definitions evoke doubts. What is a functional equilibrium? According to the basic physical rules, without imbalances in potentials no flow of energy is possible. In the next description one can find some elements of physical efficiency mixed with effort tolerance. The *functional equilibrium* appears once more in the third definition quoted. Moreover, this description includes only the aerobic mechanisms of energy transformation.

Taking the previously mentioned into consideration, the authors suggest the following definition:

Physical efficiency – Conditioned by physiological processes, efficiency of energy transformation in a living organism, measure of which is power which a given organism is able to develop at a given moment of a performance.

Another basic notion is endurance. Kuński defines it as follows:

Endurance – "*Ability of an organism for a long-lasting performance of effort with constant intensity (power) or maintaining the constant muscle tonus. It may be perceived as the feature which conditions the resistance of the organism to fatigue, local or overall. It may be measured with units of work or effort intensity (power as physical quantity)*" (2002, p. 196).

This definition evokes many doubts. What is a *long-lasting performance of effort*? Why does the effort have to be *long-lasting* (what about the endurance of a sprinter)? Why does the intensity of effort have to be *constant*? The resistance of an organism to fatigue is an exercise tolerance, and not endurance. And last but not least, work and power are different physical quantities, thus it is not possible to *translate* them simultaneously into the same physiological quantity, namely, endurance. Hence, in this paper the following definition is proposed:

Endurance – Capacity of a living organism to make an effort, the measure of which is maximum work which this organism is able to perform in one, uninterrupted act until the limit of exercise tolerance is reached.

The notion of *exercise tolerance* has been defined by Ronikier in two ways. The first definition reads:

Exercise tolerance – "*Capacity of an organism for a long-lasting performance of an effort with given intensity, without serious disturbance of homeostasis (e.g., increase of concentration of hydrogen ions in blood) and impairment of the function of organs (e.g. hypoxia of the heart muscle)*". (2001, p. 12)

The second definition is:

Exercise tolerance – "*Range of capacity of an organism to perform physical work from the first signs of discomfort until the necessity of interrupting (breaking) the work appears*". (2001, p. 15)

Kuński distinguishes two different but associated notions. The first one is:

Exercise tolerance – "*Capacity for long-lasting performance of physical effort with given intensity without a serious disturbance of homeostasis and impairment of organs (e.g. hypoxia of heart muscle).*" (2002, p. 194)

The second one is:

Post-exercise tolerance – "*Capacity for quick removal of fatigue signs. Its measure are indexes of post-exercise recovery (rest), e.g. pulse or breath frequency, systolic blood pressure, concentration of lactate in blood.*" (2002, p. 194)

All definitions quoted previously evoke doubts. What is *long-lasting effort* or *serious disturbance of homeostasis*? Why does the exercise tolerance occur only by the first signs of discomfort? Nevertheless, the differentiation of the notions *exercise tolerance* and *post-exercise tolerance* made by Kuński is very accurate. Taking all this into account, the following definitions of the notions under consideration have been suggested in the presented paper:

Exercise tolerance – The range of physical efficiency from maximum to minimum values; reaching the latter results in decreasing to zero the capacity to expenditure of energy of desirable intensity.

Post-exercise tolerance – The range of physical efficiency from the minimum value (state of extreme fatigue) until the level of stable efficiency has been reached after complete recovery.

The phenomenon illustrating the correlations among all the notions defined previously is supercompensation (Figure 1). Taking into account that in terms of physics the measure of physical efficiency is power, it is possible to rename the vertical axis of the diagram without changing its *physical identity.* Thereafter interpretations in terms of physics of the notions under consideration become clear (Figure 2).

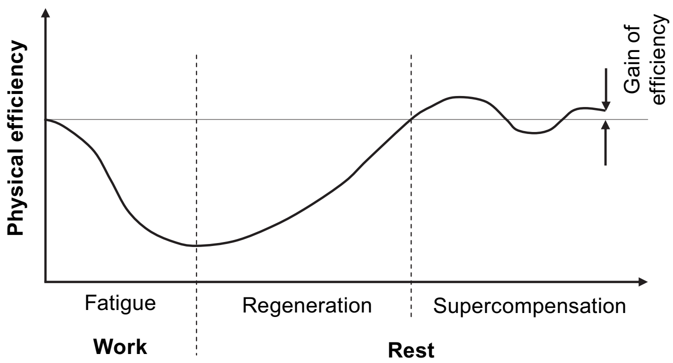

Figure 1. The phenomenon of supercompensation according to Nikolai N. Yakovlev (Winiarski, 1989, p. 60)

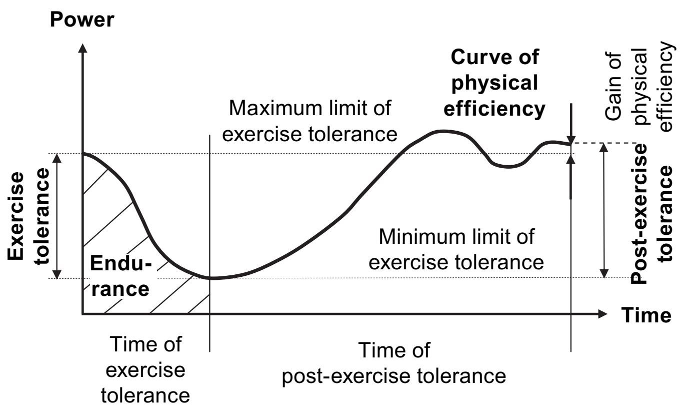

Figure 2. Correlation between physical efficiency, endurance and exercise tolerance.

For both the coach and the athlete not only the range of physical efficiency is important, but also the time of reaching the minimum value of physical efficiency (exercise tolerance) or the time of reaching the optimum value of physical efficiency, possibly with the gain in efficiency (supercompensation; post-exercise tolerance).

It is worth remembering that the work amounts to the product of power developed and time, when an organism makes an effort. This is graphically represented by the field filled with lines under the curve of physical fitness, during the time of exercise tolerance, in accordance with the definition of endurance proposed in this paper: the work done by an organism from the beginning of energy expending until the minimum limit of exercise tolerance is reached. It has to be noted that the maximum limit of exercise tolerance – closely connected with physical efficiency and endurance – is determined by **physiological** factors, while the minimum limit of exercise tolerance is determined by **environmental** factors. Thus, the particular values of physical efficiency, endurance, exercise tolerance and post-exercise tolerance depend on both the physiological conditions and environmental loads.

3. The notion of force

Typical intralingual inconsistencies are connected with the word *force*. According to the *Oxford Dictionary of Sports Science and Medicine* by Michael Kent (1995), it means:

Force – "*The effect one body has on another body so that it can cause or tend to cause a body at rest to move, or cause a moving body to slow down, stop, increase its speed, or change its direction (...) Force is measured in newtons and is the product of the mass of an object and its linear acceleration; that is, force = mass × acceleration. On the basis of this formula, three different types of forces may be identified: shear force, fast force and endurance force*". (1995, p. 174)

As said previously, Kent also mentions some other terms such as *shear force*, *fast force* and *endurance force* and denotes them in the following way.

Shear force – "*A force identified on the basis of formula: force = mass × acceleration, in which the mass component, or resistance to be overcome is more important than acceleration (...)*". (1995, p. 397)

Fast force – "*A force identified on the basis of the following formula: force = mass × acceleration, in which the acceleration component contributes more than the mass (...)*". (1995, p. 164)

Endurance force – "*A force identified on the basis of the following formula: force = mass × acceleration, where neither the mass, nor acceleration component prevails*". (Kent, 1995, p. 148)

Here we come across two basic inconsistencies. The first one results from the fact that both the factors on the right hand side of the equation (mass and acceleration) completely *melt* during the transformation and the quantity on the left hand side of the equation sign (force) is fully homogenous, i.e. it is impossible to distinguish, which *part* of force originates from mass, and which *part* from acceleration. Both factors, mass and acceleration, are incomparable; there exists no *common denominator* enabling the comparison of these physical quantities. Hence, the *contribution* of mass or acceleration cannot be regarded as a criterion of *force types* differentiation, because force simply does not *see* anything on the other side of the equation sign; so, it is completely insensitive to the proportions of mass and acceleration. Then the question which of the two quantities prevails, reminds us of the question whether an apple is redder or sweeter. So, the differentiation between shear force, fast force and endurance force has no real physical grounds because – it should be repeated with emphasis – the force cannot *see* what is going on at the other side of the equation sign. All these terms are based on the wrong interpretation of Newtonian rules and should be removed from the sport scientific terminology by means of the Reverend William Ockham's razor.

The other basic inconsistency results from the fact that the Newtonian formula is usually expressed with words: *force equals mass times acceleration.* Such an interpretation of the formula may be seen as the background of all the definitions quoted previously. The main mistake lies in the fact that force cannot be identified with the product of mass and acceleration. Such a product may serve as a **measure** of **force**, but it is not force itself. The force exerted against a concrete wall causes no acceleration (apart from the slight deformations of the wall) thus according to the Newtonian formula:

$$F = m \times a$$

it does not exist at all! If acceleration is equal to zero, then the whole product has to amount to zero. In such a situation the existence of force that does not cause any acceleration would not be possible.

Richard A. Schmidt and Craig A. Wrisberg introduced another term, *strength*, and defined three *types* of it.

Explosive strength – "*The ability to expend a maximum of energy in one explosive act (...)*".

Static strength – "I*nvolves the exertion of force against a relatively heavy weight or some fairly immovable object (...).*"

Dynamic strength – "*The ability to repeatedly or continuously move or support the weight of the body*." (Schmidt & Wrisberg, 2004, p. 36)

In other words, the differentiation between dynamic and static strength depends not on strength itself, but on the character of a body upon which the force acts. If it is exerted against an immovable object, then it is called *static strength*, if exerted against a movable object – then it is *dynamic strength*. The second formulation quoted is not a definition at all, because it does not say what *static strength* is; instead what is stated is which phenomena are connected with the action of *static strength.* Moreover, the descriptions *relatively heavy* or *fairly immovable* do not express the heart of the matter. Here the main physical quantity is inertia: the mass is its cause, and mobility – its result. Nevertheless, all the notions defined previously are not substantiated by the rules of physics (Newtonian laws), thus they should also be removed from strict, scientific terminology.

More complex is the analysis of the notion of *explosive strength.* According to the definition quoted by Schmidt and Wrisberg, it is simply power as understood in physics (the quotient of work done and time of given motor action, or, more exactly, the first time derivative of work). So, the notion of *explosive strength* as defined previously, being in fact a synonym of physical power, has no justification. Nevertheless, it is sometimes identified with the notion of *Rate of Force Development.* Dietmar Schmidtbleicher wrote:

Die Fähigkeit der schnellen Kraftentfaltung, in der internationalen Terminologie als "Rate of Force Development" (RFD) bezeichnet, wird in der tradierten deutschsprachigen und osteuropäischen Literatur in Anlehnung an Werchoshanskij auch Explosivkraft genannt.

The ability to create force quickly, referred to in international terminology as "Rate of Force Development" (RFD), has been named in common German and East-European literature "Explosive force", according to Werchoshanskij. (Schmidtbleicher, 1987)

Schmidtbleicher (1987) also explains *starting strength* or *starting force* as *explosive force* at the moment when the movement starts. Thus, such a differentiation is not necessary at all. The graphic illustrations of starting force, explosive force and fast force are shown in Figure 3.

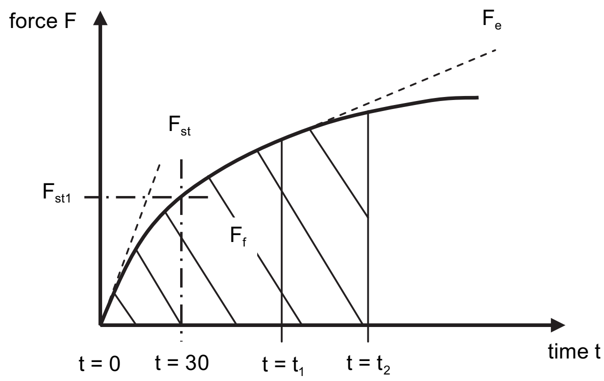

Figure 3. The process of force development: ***starting force*** *F_{st} according to Schmidtbleicher,* ***starting force*** *F_{st1} according to Kent,* ***explosive force*** *F_e at the moment $t=t_1$ and* ***fast force*** *F_f in the time interval from $t=0$ to $t=t_2$. The measures of F_{st} and F_e are angles of inclination of tangents to the force diagram curve, while the measure of F_f is the shaded field under the curve. The F_{st}, F_e and F_f are termed "forces", indeed, but none of them is really a force: F_{st} and F_e are rates of force development (first time derivatives of force) and F_f is the impulse. The quantity F_{st} by Kent, being a concrete value of force, testifies to a lack of order in the terminology in this field (Petryński, 2004, s. 261).*

What results from the previous description is that it is not the **force**, but the **rate** (of force development), i.e. the first time derivative of force. Thus the *explosive force* is not a force, but a measure of its changeability. As such, it is completely useless for movement behaviour analyses. The rate of **force** development gives no information whether any **work** has been done or not. If, for instance, the force is exerted against an immovable object – say, a concrete wall – then the work done amounts to zero. If the force acts along a distance, then it produces physical work. However, the sheer amount of work gives no information about the dynamics of a process in which the force is involved. Such information gives the first time derivative of work, i.e. **power**. Thus, power has a much larger *information capacity* than *explosive strength*. Nevertheless, normal power makes only one of the bases of a **motor skill**. To sum up, the name *explosive force* is misleading, because in fact it is not a force, but only the first time derivative of force, i.e. the measure of force changeability. Moreover, its *information capacity* and usefulness is highly doubtful because of the considerable length of the cause-and-effect chain - from the fundamental muscle property to a highly intricate motor skill. Thus, if it did not exist in a scientific dictionary, probably nobody would even notice it.

In movement science the notion of *force* has two meanings which have to be clearly distinguished. The first of them denotes **physical quantity**, whereas the second denotes **physiological motor ability**. In the English language one may distinguish between these two meanings semantically, because two different words exist for these two denotations - force and strength. They might be defined as follows:

Force – Physical quantity, mutual action of bodies, solid, liquid or gaseous, direct or from afar (e.g. magnetic or gravitational), the measure of which is the product of mass and acceleration which really encounters or potentially may encounter the body upon which the force acts.

Strength – Conditioned physiological energy-related ability of a living organism to exert a muscular force against another body that is in its environment, directly or through some other body - solid, liquid or gaseous.

The same situation is in German, where we have at our disposal the words *Kraft* (physical magnitude) and *Stärke* (muscular force). However, in Polish there is only one word *siła*, and in Russian too (*сила*). In Polish there exists the word *krzepa*, and in Russian *крепость* or *мощность*, but in contemporary movement science they would sound rather exotic or outdated. Moreover, English scientists often use the terms *force* and *strength* as synonyms. Nearly the same situation is in German with the words *Kraft* and *Stärke*, although Germans use the word *Stärke* extremely rarely. Hence, in English and German it would be highly advisable to use the words *force* or *Kraft* for a description of the physical quantity, and the words *strength* and *Stärke* to describe the motor ability. In Polish and Russian there is no such possibility. Nevertheless, the fact of the inconsequent use of the words under consideration is a sign of a very dangerous phenomenon: the negligent use of language in science.

4. Inconsistencies in the description of motor activity

The phenomenon of inconsistency in terminology can be encountered also in the famous handbook by Schmidt (1988). On page 65 one can find the following figure (Figure 4).

The abbreviation RT means *Reaction time*. The inconsistency is clearly visible: the time between events called *Response begins* and *Response ends* is referred to as *Movement time* and not *Response time*! Moreover, the item called *Response time* lasts from the moment *Stimulus presented* until the moment *Response ends.* The same figure can also be found in the fourth edition of the book, written by Richard A. Schmidt and Craig A. Wrisberg (2005, p. 32). To retain the *semantic purity*, which in this case is equivalent to *notion purity* and *thinking purity*, the figure should look as follows (Figure 5).

In the preparatory period (A) only the information processing develops without any muscular activity. The latent period (B) of the sensorimotor response begins from the appearance of a stimulus; the length of this period is the reaction time (RT). This period consists of two sub-periods: the premotor latent response (PLR), when no electromyographic activity is recorded, and the motor latent response (MLR), when EMG activity is recorded, but no movement has been observed yet. Then comes

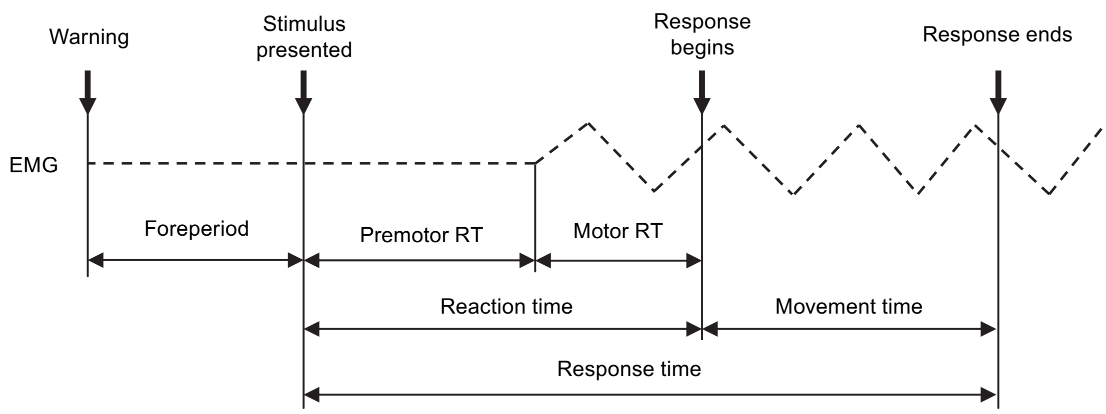

Figure. 4. Critical events involved in the reaction time paradigm. (The upper trace is a hypothetical EMG record taken from the relevant muscle.) (Schmidt, 1988, p. 65)

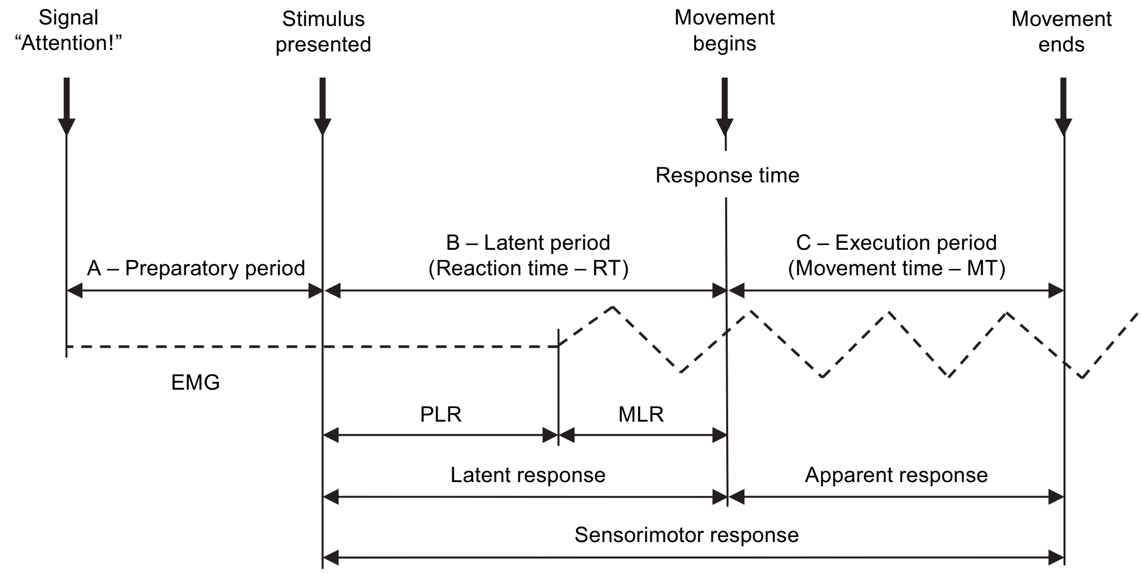

Figure 5. Proposed sensorimotor response scheme. PLR – pre-motor latent response; MLR – motor latent response (Petryński, 2002)

the execution period (C), when the movement is performed (apparent response); the length of this period is the movement time (MT). Both the latent response and the apparent response represent the sensorimotor response.

5. Summary and conclusion

The presented, selected examples of semantic inconsistencies unveil some questions to be dealt with. It is necessary to deal with the following problems:

- to make the movement science terminology congruent with the basic physical and mathematical rules,
- to base the movement science terminology on a general language as much as possible, i.e. to create new terms only when it is really inevitable,
- to create an English encyclopaedic movement science dictionary; the exclusively English-speaking scientists should not be entrusted with such a task, because such a dictionary should be written using extremely simple and unambiguous language,
- to create national dictionaries of movement science taking the English encyclopaedic dictionary as a *point of reference* or *lighthouse*; nevertheless, the influence of other languages has to be taken into account, too, because English is sometimes not very precise and some terminological inconsistencies are better visible in some other languages.
- to accomplish such a task, it seems to be highly advisable or even necessary to appoint national committees and an international committee that would deal with the movement science terminology.

It should be stressed once more that it is the language and terminology that create the very basis of understanding and the most primeval stuff of science. All facts have to be projected into the abstract sphere of mind and words are the "bricks" by which science is built. They enable both communication between scientists and projecting the reality into the sphere of the mind, i.e. they make it possible to build abstract models of reality in theory; precisely this is the main task of science all over the world. Thus, without a structured, solid, unambiguous language it is impossible to develop science at all. And to build such a language, it is absolutely necessary to create an **international, encyclopaedic dictionary of physical culture**.

The branch of physical culture sciences especially vulnerable to semantic incoherencies is the human movement science (anthropomotorics, anthropokinetics, kinesiology, anthropokinesiology, etc.). Its basic task is to build the models – made of words - of human motor behaviour. The proper model enables simulation, i.e. virtual examination of the behaviour of a theoretical model under the influence of various stimuli. If the model is constructed correctly, it will behave analogously to the real object. Good examples are crash tests of cars, known from technology. The theoretical models used in technology have been worked out logically correctly and enable computer simulations of crashes which increase the pace of projecting, raise the safety of car construction, and decrease the expenses through a significant lowering of the number of prototypes that have to be destroyed during the tests. Logically correct models of human motor behaviour would enable a more efficient training process, avoiding errors and a quicker attainment of the mastery level.

At the very end it is worth to mention one of the most outstanding contemporary scholars, the founder of the physiology of activity – Nikolai Aleksandrovitsch Bernstein. He was not only a giant of scientific thinking, but also a master of language, and not only of the scientific language. His works might serve as a model of the lucidity and clarity of language; he also wrote wonderful poems. It is not without significance that he spoke eight foreign languages. Thus, it would be highly appropriate to dedicate such an encyclopaedia to N.A. Bernstein.

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IZABRANI PROBLEMI MEĐUNARODNE TERMINOLOGIJE ZNANOSTI O LJUDSKOM KRETANJU

Moto:

Ono što je nužno jest nazvati stvari njihovim pravim imenima

Konfucije

Sažetak

Autori raspravljaju o pitanjima terminologije znanosti o ljudskom kretanju i ističu činjenicu da je područje terminologije (zajedno s područjem istraživanja, predmetom istraživanja, metodama i metodologijom) temeljna epistemološka pretpostavka svake znanstvene discipline. Čini se nemogućim graditi apstraktne modele stvarnosti, što je temeljna zadaća znanosti, bez ispravne terminologije, zbog toga što su riječi glavni građevni materijal za teorijske modele. I tu je korijen ogromnoj odgovornosti za izbjegavanje nejasnih riječi i uspostavljanje jednoznačne terminologije, koju odgovornost moraju preuzeti znanstvenici, danas osobito oni engleskoga govornog područja zbog toga što je engleski jezik najčešće rabljeni jezik suvremene znanosti. Nažalost, čini se kako znanstvenici nisu uvijek dovoljno svjesni toga problema, pa se kao posljedica javlja nedosljedna i nejasna uporaba nekih termina u znanosti o ljudskom kretanju. Taj fenomen postaje osobito opasan u prijevodima s jednog jezika u drugi zato što netočna, nejasna uporaba termina postaje još nejasnijom u postupku prevođenja. Stoga autori u svome članku razlikuju dvije vrste lingvističkih problema – unutarjezične i međujezične probleme.

U radu su predstavljeni neki primjeri očito nedosljedne uporabe temeljnih termina znanosti o kretanju. Autori raspravljaju o pojmovima tjelesne (motoričke) učinkovitosti (*physical efficiency*), izdržljivosti (*endurance*) i otpornosti na vježbanje/umor (*exercise tolerance*). Prvo navode definicije drugih autora i pokazuju njihovu očitu nekonzistentnost. Čini se da glavni izvor nedosljednosti leži u tome da se svaki pojam promatra odvojeno od drugih pojmova, dok svi oni, u stvari, čine koherentan sustav. Stoga autori prvo pokazuju uzajamnu ovisnost svih navedenih pojmova i okreću se temeljnim fizikalnim izvorima da bi ispravno opisali termine i izgradili njihove koherentne sustave. Uzme li se u obzir sve rečeno, tada se dolazi do spoznaje da bi se taj sustav trebao sastojati od četiri pojma: tjelesne (motoričke) učinkovitosti (*physical efficiency*), izdržljivosti (*endurance*), otpornosti na vježbanje/umor (*exercise tolerance*) te otpornosti na umor nakon vježbanja[1](*post-exercise tolerance*). Ta četiri pojma tvore logičan sustav koji odgovara temeljnim zakonima fizike i koji je čvrsto ukorijenjen u biološkoj realnosti. Osobito je ilustrativan fenomen *superkompenzacije* koji je temelj svakom treningu, i sportskom i rekreacijskom.

Nadalje autori raspravljaju o pojmu sile (*force*) i svim mogućim njenim *inačicama* koje se rabe u znanosti o ljudskom kretanju. U fizici je sila aksiom, pa se može opisati jedino pomoću učinaka koje proizvodi u okolišu. Najpopularniji opis sile dao je Newton u drugom zakonu mehanike koji pokazuje odnos sile, mase i akceleracije. Postoje, međutim, i drugi opisi sile (primjerice, Hookov zakon). No, kruto inzistiranje na tome da se u svakoj situaciji pojam sile poveže s masom i ubrzanjem (akceleracijom) ponekad može biti paradoksalno. Čini se kako pojmovi posmična sila (*shear force*), brza sila (*fast force*) i dugotrajna sila ili sila izdržljivosti (*endurance force*)[2], koji su potpuno uobičajeni u znanosti o ljudskom kretanju, nemaju svoje korijene u fizici. Također nisu sasvim jasne ni granice između pojmova *sila* i *jakost*. S fizikalnoga stajališta osobito su dvojbeni pojmovi *eksplozivna jakost, statička jakost, dinamička jakost* ili *startna jakost*[3] S fizikalnoga stajališta neki od navedenih termina uopće ne označavaju silu. Autori sugeriraju dvije definicije sile koje bi mogle biti korisne u znanosti o ljudskom kretanju i koje su kongruentne s općim fizikalnim zakonima; prvi opis označava *silu* kao fizikalnu veličinu, a drugi opis označava *mišićnu silu*, tj. *jakost* kao motoričku sposobnost.

Nakon toga se autori osvrću na paradigmu *vrijeme reakcije* i ukazuju na semantičke i logičke nedosljednosti u modelu (razlika između *vremena reakcije* i *vremena odgovora*). Sugeriraju konzistentan model obrasca senzomotornog odgovora.

Nakon rasprave o navedenim problemima, autori predlažu točnije definicije nekih uobičajeno korištenih termina. Ukazuju i na potrebu da se izradi međunarodni enciklopedijski rječnik znanosti o ljudskom kretanju.

[1] sposobnosti oporavka (op. prev.)

[2] U zagrebačkom kineziološkom krugu ti se termini ne koriste (op. prev.).

[3] U zagrebačkom kineziološkom krugu za te se pojmove rabe termini: eksplozivna snaga, statička snaga, repetitivna snaga i brzinska snaga (op. prev.).