

## Training & Coaching Science

(update Training&for ICSSPE 5th Edition)

### From Neurobiology to Training & Coaching Science

Mark Wertheim

#### 1. General Information

Sport Science/Theory pertain a group of sciences that based on different Sciences with relation to sports such as: Anatomy, Medicine, Physics, Biomechanics, Psychology, Sociology, Physiology, Nutrition, Statistics etc.

The traditional structure of Sport Science was divided to sub-sciences with connection to sport, such as: sport -psychology , sport -medicine, sport- physiology, sport -pedagogic etc. The field- Sport Science did not develop tools for a specific process for training, and we find a mixture between theory and practice.

The previous structure of Coaching-Science (2008) did not have enough scientific evidences to create a scientific diagnosis between theory of training and practice training as complementary sciences. The practice part called training /Coaching was taken as forms of exercises without enough evidence Data.

There was not a clear separation between Training and Coaching, and especially between theory and practice, and it was not clear how to combine them in Training process as whole scientific process of Teaching & learning & Coaching.

Till now, we find Coaching Science/Theory that deals in mixture with coaching and training.

In addition, the absent of wide Vision that Training Science and Coaching Science are both scientific fields, caused to various influences from different science without connection between them. This situation did not enable to connect between the different areas of working (health aspects, and competition aspects) end to combine them in training. The contest of Coaching was naturally connected mostly to competition sport.

This new definition of training & coaching science will focus the research, methods and structures of training and coaching as out put from Neurobiology evidences.

Neurobiology is the core of the latest development in most of the Sciences and Sport Sciences. In our days, Sport Sciences are focusing on the Question: What is the optimal mutuality between various movements, abilities ,thinking, emotions and cognitive Process. Training Science and Coaching Science passed reform in contests an structure due to new evidences and results from researches in Neurobiology and especially researches with connection to Sport Science.

This Chapter confines the new meaning and structure of Trainings & Coaching Science based on last researches in **Neurobiology** and how to apply in Training

Up to the new meaning, **Training –Science** is the process of **planning** the trainings, while **Coaching – Science** is the **theory and methodology of the practice training** as a process between coach and athlete/ athletes.

The recent innovation in Neurobiology and Brain –Science and their influence on teaching & learning& Coaching process as whole process, and the understanding that Brain and Nerve-System as whole are standing in the middle of training and are the stimulus of the process teaching & learning& Coaching, caused to focus on two areas:

1. Training –Science as a process of developing theory of planning training
2. Coaching –science as a process of practice training as a combination between individual development and methods of teaching & learning& Coaching.

The new definition enable us to consider different physical activities , in a range of sport fields, levels and ages with focus on prevention , achievement goals in sport and competition based on physical and emotional health, and rehabilitation . It is clearer that the core of training and its basis is not a complex of achievements components such as condition, technique, tactic, mental abilities, intellectual ability and educational process, (Wertheim 2004)

In the center of training & coaching stay neurobiology and its practicable form –Coordination in combination with Technique

### 1.1. Historical Developments

Until the 20th century, coaching was done by instinct, tradition and personal trial and error. A real theory began to develop (mainly in measurable sports, such as track and field, and on the subject of developing physical ability) when coaches called upon experts in exercise physiology for advice. By the 1950s, coaching theory came of age, initially in the Soviet Union and its satellites, with the work of Matveyev et al., on coaching theory, especially on periodisation of training. The East-West competition, with attendant government support, fuelled both coaching practice and the development of coaching theory. In the 1970s, upgrading coaching by means of increased volume had reached its limits and increasing intensity was called upon; but this, too, was nearing its bounds. So, in the 1980s, coaching theory (and practice) turned to periodical shifting of emphasis on different elements of ability, on increased specificity of exercise and on ergogenic aids (initially of metabolic, later of hormonal nature).

Coaching science, which began as a copy of successful methods of coaches, in the 1990s focused on the question of “why”, via interdisciplinary research and asks the questions of what is the best method for the effectiveness of coaching over the short, medium and long terms in the areas of preventative, sport functioning and rehabilitation.

The search for the scientific base accompanies the theory and structured methodology (the theory of coaching), which cannot exist in disciplinary sciences that do not have a direct base on which to work. Coaching sciences in the 2000s do not based on pedagogical principles, as they were in the past, and on the physiological principles of a few years ago, but on the interaction between them with the understanding of the connection between the educational process in coaching and the physiological process (Wertheim, 2004).

Nowadays, the researches and the evidences in different sciences during physical efforts indicate that there is another discipline and important one that influences on understanding the process of training and coaching. This important discipline is Neurobiology.

The change from the last concept of coaching science (2008) to Training and Coaching Science (2012) shows a trend towards a discipline based on neurobiology knowledge that enable to develop theory based on Brain science and neurophysiology, and practice relay upon it. The reliance between theory and practice is emphasized and there is more understanding that the foundation of the achievement components are coordination and technique. It is also clear that the achievement components should be developed in different ways of teaching and learning ( schoellhorn 2009).

### 1.2. Body of Knowledge for Understanding-Training Science

Training Science in Sport science is the theory of planning long, middle and short term periods of training, depending on Age, Goals and Population. The core of training science is creating a structure of training that based on neurobiology and other sport Sciences as a base to coaching science and providing an efficient Adaptation- process.

Training science /theory brings together data from neurobiology, exercise physiology, biomechanics, sports psychology, sports medicine, sports sociology, kin anthropometry, motor learning, sport pedagogy, etc., as well as empirical data from coaching in all sports. From a coaching aspect, these data can be combined to form a multi-disciplinary, applicative discipline.

Training science as an interdisciplinary, integrative science based on the systematic collection and collation of significant data from coaching areas, sourced from competition, laboratory and fields based experiments.

Training science explain the process based on researches of leading/guiding an athlete or team to maximize performance in the chosen activity (prevention, sport, rehabilitation). In competition sport it means especially from intermediate level upwards at the most important competition of the period.

All kinds of improvements of the physical activities in a process depend on adaptation. Adaptation is the main aim of training (in planning) and coaching (in practice – as a process between the coach and the athlete). It occurs first in the central nerve system, that has to be adapted in systematically way.

The latest researches deal with the relation between different sorts of exercises and Brain Cells and functions of the different parts of the Brain during specific exercises that combine ways of observation and absorbing different information. Physical activity that combine different exercises and especially complicated exercise with different stimulus-induced neurotrophins such as brain-derived neurotrophic factor (BDNF), vascular endothelial growth factor (VEGF), as well as the neurotransmitter dopamine are needed to grow and fertilize new and existing neurons and their synapse connections.

Those evidence explain the importance of creating adaptation through specific exercises in order to create neuronal adaptation.

The many aspects of training science include relevant knowledge for building a training plan based on Adaptation process. Due to the latest evidence in Neurobiology, there are 3 fields of Adaptation:

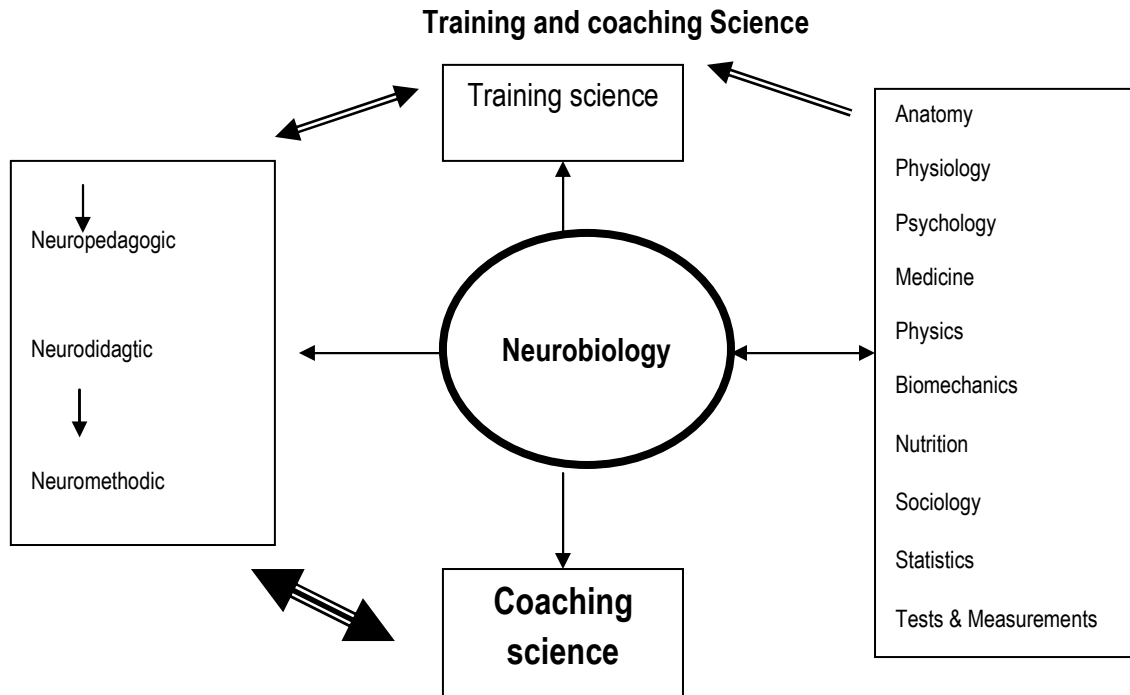
- neuronal-adaptation (coordination and technique)
- emotional and cognitive –adaptation (individual and /or team tactic)
- energetic –adaptation (strength and endurance)

Training science include all those 3 kind of adaptation that being developed in stepwise progression.

Training science search and recommend principles for:

- Understanding the anatomy and physiology of the Brain
- Anatomy and physiology during physical efforts and adaptation
- Emotional and physical health of the athlete in training and competition
- Improving the physical fitness of the athletes
- Loads and recovery of nerve System
- Guiding the athletes' nutrition
- Understanding biomechanics in relation to technique
- Developing strategies for acquiring technique and tactics
- Developing abilities of observation and absorbing different information
- Mental Preparation of athlete/ team
- Developing intellectualize athlete
- Planning and measuring training loads and recovery means
- Analyzing achievements in training and competition
- Acclimatization when preparing for tournaments to be held abroad
- Identifying talented youngsters and how to develop them to maximize their talent in sport.

Today, more than ever, there is an understanding that the connection between theory and practice in training hang on application of neurobiology in form of: Neuro pedagogic, Neuro -didactic and neuro –methodic (coaching science).



Up to the new point of view of Training Science and Coaching science, coaching science focused on providing guidelines and principles for effectively carrying out this task in a bidirectional process between coach and athlete.

All this together enable to apply rationally and effectively Coaching science

### 1.3. Body of Knowledge for workout -Coaching Science

Coaching Science in Training Science is the theory of teaching & learning& coaching aspects in training.

The core of Coaching Science is creating a structure of systematic training based on neurobiology under certain aspects that a trainer should consider:

- Posting Goals –general, specific and individual
- Posting Goals considering athletes' development and in relation to his abilities
- Ways of transfer information **under** neurophysiologic aspects
- Organizing and planning systematic exercises (sequentially energetic chain )
- Creating various stimulus
- Movement and play in relation to coordination components
- Output as neurobiology complex movement
- Individual treatment to each athlete as addition to the general training

Competition sport is characteristic with excellence skills. High level of different skills, especially none cycling skills, require high level of coordination. In the past, there was an "ideal" skill to be achieved, and therefore the training was based on high number of repetitions of this skill and technique in different exercises.

Due to evidence in neurobiology, it is clearer, that repetition of skills through technique exercises, is not the best way to achieve general "ideal" movement /technique, because there is not an " ideal movement" (generally and individually).

Researches found, that it is almost impossible to repeat the same movement twice. There are always small differences ( schoellhorn 2009 ). To develop an individual Technique there is a need to train first coordination skills as preparation for technique, in many different situations based on coordination components for example OCO system (wertheim 2011) or on differential learning and teaching (Schoellhorn 2009).

After this it is recommended to teach technique with combination of coordination skills to produce individual applicable technique.

To summarize the main topics in coaching:

- Individual treatment
- Various exercising (drills)
- Various stimulus and absorbing information
- Various movements
- Strategy of finding suitable solutions
- Strategy of teaching the athlete understanding the transfer process: from cause to result
- Correcting errors in form of exercising in different situation based on coordination and technique.

The goals of training science is how to combine the whole scientific knowledge to applicable tools in complex of theory of training.

Coaching science as a practical science, focus on the dynamic development of an athlete in connection to his ability to transfer information to a process "cause and result".

Till some years ago, coordination was a sub component in technique or one of the components of physical condition.

Today coordination is the core of training and coaching science and influences all other components.

In the future will be investigated the dual influence between coordination and nerve -cell function.

Coaching science as a practicable process, place in the middle the trainer and the athlete as well. It combines neurobiology evidences in 3 steps: Neuro pedagogic aspects, Neuro –didactic aspects and Neuro-methodic aspects.

The concept of Coaching Science in modern terms is to produce a planned training process, writing each training and control tools to every step in training.

Coaching science recommend ways of working in trainings

#### A. : NEURO PEDAGOGIC

##### I Development

- Individual development
- Interpersonal abilities
- Synchronization between different small groups in training

##### II Methods of teaching

- Instruction of general coordination
- Instruction in the technique of the specific sport art

##### III Methods of socialization

#### B. NEURO –DIDACTIC

##### I ways of learning –first adaptation

- Pre –situation
- During performance
- After performance and before a new performance

##### II way of practicing-second adaptation

- Varied situations based on systematic procedure

##### III ways of training-third adaptation

## C. NEURO-METHODIC

### I purpose

- Purpose of training
- Purpose of exercise

### II Purpose and Timing

- Timing of the explanation of an exercise pre execute

### III performance in unusual start points

### IV after performance

- direct feedback from athlete
- cognitive transfer ability

### V produce tools so the athlete will understand the process and its details

### VI teaching the athlete to write training exercise

### VII training methods

### VIII transfer trainings forms to different situations in competition

- instruction for specific coordination
- effective application of the sports' techniques
- providing technical, tactical and mental assistance during training and preparing for a competition,
- Analyzing past training and competitions to develop future objectives training process based on this analysis.

The purpose of training is to create adaptation. The 3 steps of adaptation are shown in training planning as follows:

#### First adaptation—neuronal adaptation

This part contains:

Teaching tools that the coach can use in order to teach the athlete Coordination & technique.

Choosing ways of teaching - the athlete to learn ways of observation and observing different information.

Achieve Coordination, technique and combination of them under different stimulus (audio, visual, sensory, irritation stimulus). The different stimulus is given generally and specifically and provide Concentration ability.

Coordination & technique combined with achievements components, (mobility, flexibility, elasticity, non cycling speed, various strength ability, endurance and stamina tolerance) on one side, and on the other side combined personality development, Intellectual process, processing, details maintaining. All these produce the basis for first adaptation and efficient functioning in variable situations and coincidental situations.

To obtain optimal transition to second adaptation it is necessary to create stress situations and situational order functioning

#### Second adaptation—emotional & cognitive

In the center of the second adaptation standing the achievement of individual tactics, group tactics and the combination between them under aspects of individual tactic decision. Thus we create a process of regulation of output that can be suitable to different situations.

In order to achieve good performance in this stage of Adaptation it is important to combine it with practicing & training under stamina tolerance and endurance.

During the second adaptation we still Train& Coach in a different part of the training, subjects that are included in the first step of adaptation.

#### Third Adaptation- energetic

In third step of adaptation we train all achievements components together with emphasize on power and endurance in trainings and as combination.. In this step it is important to consider the profile of the specific activity / sport and in relation to the genetic of the individual athlete.

During the third adaptation we still train& coach in different parts of the training, subjects that are included in the first and second steps of adaptation but in low impact, and depending on Goals, age and special activity.

In our days the knowledge in neurobiology influence on training science on one hand, and important as guideline for coaching science on the other hand.

The scientific work in neurobiology and in Brain science is in the beginning and there is still a lot to be studied, but the tools and the knowledge that already exist enable us to plan a better scientific coaching with a better scientific training.

#### **1.4. Methodology**

Previous years methodology was based on Data "imported" from the various disciplines mentioned above, was formed under the methodology of the relevant science so they must then be checked, empirically and logically, for their relevance to coaching. A common pitfall occurs when data gained from general populations is used for coaching elite athletes, whose physical characteristics and mental attitude are entirely different.

Data gained from coaching practice depend, to a large extent, on the existence of orderly documentation of that practice. In most cases however, the data did not satisfy the usual criteria applied to scientific inquiries: the population was too small for statistical significance; a control group was not used as a comparison, so "double blind" studies were not tenable. This is why, previous, some experts in the field preferred the term "Coaching Theory" because it still was not a "Coaching Science".

Today most of Interdisciplinary research into sport problems take into account the complex interactions between the mechanical and physiological systems, cognition and emotion, social groupings, as well as political and economic factors under basics aspects of: teaching- learning based on neurobiology evidences. These areas of research have direct impact practical and scientific consequences on the whole complex of training & coaching as adaptation process. Topics such as: talent identification, trainings programs, children coaching as well as prevention and treatment of sport injuries, are more efficient when they base on neurobiology researches.

In the last years, the enormous development of methodology in Brain-Science enable us to understand better the teaching-learning process and enable to develop methodology of comparison between the traditional form of training ( repetition of skills in sport art) and the new form of training ( different stimulations in 3 steps of adaptation).

Those changes, created 2 levels of methodologies that connected one with the other: First level of methodology is Brian science and interdisciplinary sciences (research and methodology) considered today as the core of training science. The second level- the applied level of methodology is the coaching science that based on methodology of transfer of information from coach to athlete to create stepwise adaptation in all body systems( 3 level adaptation).

The scientific character of training science our days, become more pronounced: the measurement of an athlete's state of training become more accurate and reliable, use of microelectronics devices like in power measurements is more common. The revolution in neuroscience and measurements that measure the nerve system function and a single nerve cell will be in the future more integrated in training science, the knowledge gained from FMRI, will be applied in personal training . This will enable more objectivity in the process of coaching a team and especially in individual training (theory) and individual coaching (practice). Thus, coaches and scientists will develop together a greater degree of precision in understanding exact stimulations in training, creating better exercises based on controlled achievement factors. For example the loading process

will be suitable to individual profile of the athlete with consideration to the specific profile in sport art . The methodology of coaching will be more accurate and can be controlled in each time period of coaching.

The coach will achieve more rational and effective coaching and the scientist will gain a deeper understanding of the relation between cause and effect in training.

The massive involvement of the electronic tools, especially FMRI, enable better ways of observation and absorbing different information in coaching in every sport activity& level–amateur (sport-for-all), competitive, top-level and prevention& rehabilitation activities – will probably entail training scientist specialist as a Mentor to coach , athlete and trainings plan as a complex.

Coaching science, like all applicable sciences, amasses its knowledge through practical, supervised experiences using empirical science after follow up and/or using hypotheses that have been thoroughly assessed.

The focus is multi-disciplinary and simultaneous (application, behavior, neuro physiological profile, etc) whilst parallel to this is a collection of developing statistics in order to point to a working model, its influence and effectiveness over a period of time.

A central characteristic of coaching science is the connection between the field of the work of the coach and the trainee (through training and relevant knowledge). From here stems the reason that the field is defined as a science, as a theory and as a methodology of directing the process and development of coaching with the understanding of the needs, demands and reality.

### **1.5. Relationship to Practice**

Coaching science, as a planned process between coach& athlete is the main subject in the process of coach education.

In the past, we have had self-educated coaches (usually former athletes), who coached mainly by intuition. Sometimes they would employ aides to inform them of developments in coaching theory.

Coach education at first was based on specific data & knowledge from the specific sport art. Afterward it included also knowledge with general physical aspects.

Now days the education process of modern coach requires scientific knowledge for the theoretically part and its application in the practice part. One part of the education process relay upon the other.

So it has to be in the coach work afterward. The education process should be a model for the practice work of the coach.

In center of coaching science stand scientific planning based on diagnose of the individual nerve system level ( coordination-technique), and suitable stimulation in suitable ways. The annual plan, the periodical adjustments of that plan and the day-to-day details, must be based on coaching science, what is mean that the starts with giving general stimulations ( based on coordination) , goes to technique and specific coordination ( based on irritation stimulation) so the first step of adaptation (neural adaptation) will be achieved. This basic steps in coaching enable to develop concentration ability which is necessary to have before we start the second level of adaptation.

The aim of second level of adaptation is to create a good function of the athlete in stress situations that will enable him to contend with tactical decisions and with several conditional components.

The third level of adaptation is energetic adaptation based mostly on power and endurance and the relationship between them.

Supervision in the coaching process is done by using valid tests and practical tools to assess the results and then to adapt them to the process of planned coaching.

Central to this assessment is the interaction between the coach and the trainee, where coaching is the field of activity in which relationships and abilities develop. The principles of working as a coach are similar for all sports arts and sport



activities but in competition sport due to different of sport arts and sport levels, there are some changes in the contents of coaching but not in the principles, so this enables to develop a top level athlete without hurting his health (emotional health-Wertheim 2011)

Top-level athletes (defined as realistic contenders for medals in Olympic Games and/or world championships) in leading countries, financed by the state and/or commercial sponsors, train under close to ideal conditions. The quest for higher levels of performance leads to innovations in the process of training and thus to deeper understanding of coaching and further development of coaching science, what is mean our days that each athlete should be treated as an individual, and in various situations, and in the coaching process there is no longer needs for imitating an Idol.

Initially imitate a top level athlete, by sportsman and young athletes happen due to media reports, but it is contradicted to knowledge and principle of training & coaching science.

Imitation does not create a process as required in training & coaching science.

In all levels of sports, coaching should apply principle of 3 stepwise progressive adaptation. To achieve " healthy sport results" there is a need to make controls that related to goals.

Examples of control innovations are:

- Altitude training to enhance aerobic endurance;
- ECG-style monitoring of heart rate during performance;
- Biofeedback in mental training;
- Measurement of lactic-acid concentration to determine optimal running/swimming speed in training and competition;
- Simulation camps as part of preparation for major competitions;
- The use of computer technology and of videos for analysis and instant playback of training sessions and competition;
- The understanding and application of the process of recovery from training.
- Measurement of BDNF concentration
- Measurement of all 3 level of adaptation
- Proprioceptive devices
- Coordination analyze system ( for example OCO system)

The innovations should selected and be suited age, sport art and goals .

There is an increasing involvement of commercial firms in competitive sport, via sponsorship of special tournaments and outstanding athletes. At the same time, governments are decreasing their involvement. This is leading to a new competition timetable, which is less favorably oriented towards the athlete peaking at world championships and/or Olympic Games. This presents a challenge to training & coaching science – to develop guidelines for sensible annual planning in this changing environment, which will facilitate proper preparation of the athlete for main events while ensuring that the athlete maintains both competitive fitness and long-term health and well-being.

### 1.6. Future Perspectives

Two developments seemed to be shaping the road that training & coaching science are going to take in the future:

- A. The revolution in neuroscience and measurement in labor and on field , with help of microelectronics devices like FMRI, and the governments support in training & coaching science ( in education of coaches and in special researches institutes)
- B. The involvement of commercial firms in supporting special researches institutes ( training science) that working together with coaches, sports clubs, teams and organizing competitions –application of training science leading to coaching

science.

As electronic devices become both more sophisticated and more attainable (cheaper), much more use will be made of them to ensure objectivity of the process of training & coaching science and practice. on-line observation and analysis of the effects of coaching. Monitoring heart rate during exercise and feeding the observation into electronic data-processing instruments is already with us. It is only a question of time until non-invasive ways will be found to do the same with physiological markers of anaerobic exercise. Detailed measurements of the athlete's body (e.g. limbs and internal organs) would be fed into simulation programs, which would serve to personalize technique for optimal results.

In the future the main devices will be developed in field of:

- a. computer vision and application in sport , (exp. Savion program)
- b. coordination, will simulate stimulus irritations so the athlete will have to find the best movement-skill solution.
- c. proprioception - devices and exercises to develop better prevention sport achievement and prevention.

The increasing involvement of commercial firms in competitive sport has been discussed in section 1.5 Relationship to Practice.

Basic questions are:

1. How do you create an optimal relationship and stepwise progression between the above mentioned areas?
2. How can the results of the competition influence the coaching process and in connection to the above mentioned areas ?
3. How to analyze influence of individually and the whole team coaching on the competition?
4. How do you reduce the gap between ability (potential) and current performance of the athlete/group?
5. How to analyze which level of adaptation should be more emphasis
6. How does high-tech devices (e.g. microelectronics) impact t/ influence the training & coaching process and athlete's potential, especially stimulation devices for achieving better ways of observation and absorbing information?

In the near future, coaching systems in every field of activity will be closely monitored and documented over a period of time. This process will enable monitoring of the influence of the coaching systems (in 3 level of adaptation) and will check if the accompanying different scientific areas really have a direct and simultaneous impact.

## 2. Information Sources

### 2.1. Journals

Training & Coaching science are addressed in many journals dealing with sport science in general, and more specifically in journals devoted to training & coaching. In addition there are Journals that dealing with specifics sport art and activities and there are articles in specific training & coaching science. Among the journals:

Leistungssport (Elite Sport) (Mainz: Deutsche olympischer Sportbund, 1971-present, in German);

International Journal of Coaching Science Seoul, present in English

Coaching and Sports Science Journal (Rome: Italian Society of Sports Science, 1996-present);

Teorija I Praktika Fizicheskoj Kul'tury (Theory and Practice of Physical Culture) (Moscow: Russian State Committee on Physical Culture and Tourism, Russian Academy of Physical Culture, 1925-present, in Russian);

Research Quarterly for Exercise and Sport (Reston, VA: American Association for Health, Physical Education, Recreation and Dance, 1929-present);

Biology of Sport (Warsaw: Institute of Sport, 1983-present);

Journal of Sports Sciences (London: E&FN Spon, 1982-present);

Theorie und Praxis der Körperkultur (Theory and Practice of Physical Culture) (Berlin: Sportverlag, 1951-1990, in German);

Theorie und Praxis Leistungssport (Theory and Practice of Elite Sport) (Berlin: Sportverlag, 1962-1990, in German);

Training und Wettkampf (Training and Competition) (Berlin: Sportverlag, 1962-1990, in German);

To these journals, one must add the various journals of the sciences contributing to training & coaching mentioned in section 1.2. Function above.

There are also more practice-oriented journals, such as:

Fussball training , volleyball training , handball training, basketball training present in German

Coaching Focus (Leeds: United Kingdom National Coaching Foundation, 1985-present);

Olympic Coach (Colorado Springs: United States Olympic Committee, 1991-present);

Sports Coach (Belconnen: Australian Coaching Council, Inc., 1977-present);

Sport Pulse (Limerick, Ireland: National Coaching and Training Centre, 1993-present);

Kinesiology (Zagreb, Croatia: University of Zagreb, 1971-present);

China Sport Coaches (Beijing, All-China Sports Federation, 1992-present).

Most specific sports have their own coaching journals, often published by their governing bodies, which of course also cover coaching science.

## **2.2. Reference Books, Encyclopaedias, articles etc.**

The basic dictionary is :

Thiess, G., Schnabel, G. and Baumann, R. (Eds.). (1980). Training von A bis Z. Berlin: Sportverlag.

This has been updated by:

Schnabel, G., Harre, D., Krug, J. and Borde, A. (Eds.). (2003). Trainingswissenschaft: Leistung - Training - Wettkampf. München: Berlin: Sportverlag.

Thiess, G. (Ed.). (1987). Leistungsfaktoren in Training und Wettkampf. Berlin: Sportverlag.

A. general sports-sciences oriented reference is:

Roethig, P. (Ed.) (1987). Dictionary of Sport Science (German-English-French). Schorndorf: Karl Hofmann.  
Perhaps the most comprehensive book today is:

Harre, D. et al. (Eds). (1994). Trainingswissenschaft. Berlin: Sportverlag.

This is the 4th edition of the East German Coaching Science book, which was also translated into English (1982).

Neumaier, A. (1999). Koordinatives Anforderungsprofil und Koordinationstraining: Grundlagen, Analyse, Methodik. Köln.

"classic" books on the subject is:

Hohmann,A.,Lames,M.&Letzelter,M.(2003).Einfuehrung in die Trainingswissenschaft. Wiebelsheim:Limpert ( in German)

Holmann,W.&Strueder,H.K.(2009)Sportmedizin-Grundlagen fuer koerperliche Aktivitaet und Praeventivmedizin. Schattauer. Stuttgart (in German)

Matveyev, L.P. (1965). Problema Periodizatsii Sportivnoy Treirovki (Problems of the Periodisation of Athletic Training). Moscow: Fizkultura I Sport. ( in Russian)

Schnabel,G., Harre,D.&Krug,J.(2009). Trainingslehre-Trainingswissenschaft.Aachen. Meyer&Meyer.

Weineck,j (2004) leistungsphysiologische Trainingslehre unter besonderer Berücksichtigung des Kinder- und Jugendtrainings

**Articles**

Bartonietz,K.(2008):"Gehirn,das(Subst.):ein Organ, mit dem wir denken,dass wir denken". .Leistungssport,38 (3), 56-63

Beckmann, H., Winkel, c., & Schöllhorn, W.I. (2010): Optimal range of variation in hockey technique training. International Journal of Sports Psychology 41, pp. 5-10.

Carmeli, E., Wertheim, M. and Werner, S. (2000):Geriatric Rehabilitation Model as a Controlled Training Process. Physiotherapy, 4(1).

Carmeli,E. and Wertheim, M. (2001): Handverletzungen bei Jugendlichen und erwachsenen Sportkletterern. *Deutsche Zeitschrift Für Sportmedizin*, 52(10) Germany.

Frank, T.D., Michelbrink, M., Beckmann, H. & Schöllhorn, W. I. (2008). A quantitative dynamical systems approach to differential learning: self-organization principle and order parameter equations. *Biological Cybernetics*, 98, (1), 19-31.

Kloeckner,W.(2011): Trainer in der alltaeglichen Dysbalance zwischen Wissenschaftund Wissen-Schaffen.*Leistungssport*,41(3), 5-8.

Krug, J. (2009): Prognosen der Wettkampfleistung. *Leistungssport*,39 (2), 5-10

Hadjiev,N./ Dasheva,d.(2011): Adaptation im Sport .*Leistungssport*,41 (4), 4-7

Hagedorn,G.(2011): SportlichesTalent-zwischenTrainerauge und Molekularidiagnose . *Leistungssport*,41 (2), 5-8.

- Michelbrink, M. & Schöllhorn, W. I. (2005): Differential learning and random walk analysis in human balance [Abstract]. In C. Peham, W. I. Schöllhorn, & W. Verwey (Eds.), 2nd European Workshop on Movement Sciences. Book of Abstracts (pp. 118-119). Köln: Sport & Buch Strauß.
- Missiuna, C. (2006): Developmental Coordination Disorder, and Neurodevelopmental Clinical Research Unit (NCRU)\*, McMaster University, Canchild.
- Nieber, L./Theil, A. (2010): Koordinatives Ergänzungsstraining im Nachwuchsleistungsvolleyball. Leistungssport, 40 (1) 14-21
- Nordmann, L. (2010): Spitzenleistungen erfordern Top-trainer. Leistungssport, 40 (4), 8-12
- Pfeiffer, M. & Jaitner, T. (2003): Sprungkraft im Nachwuchstraining Handball - Training und Diagnose. Zeitschrift für angewandte Trainingswissenschaft 10, (1), 86-95
- Savelsbergh, G.J.P., Kamper, W., Rabijs, J. De Koning, J. & Schöllhorn, W. (2010): New methods to learn to start in speed skating. A differential learning approach. International Journal of Sport Psychology 41(4).
- Schöllhorn, W.I., Humpert, V., Oelenberg, M., Michelbrink, M. & Beckmann, H. (2008): Differenzielles und Mentales Training im Tennis. Leistungssport, 38, (6), 10-14.
- Schöllhorn, W. I., Beckmann, H., & Janssen, D. (2009): Differenzielles Lehren und Lernen in der Leichtathletik. In H. Beckmann & P. Wastl (Hrsg.), Perspektiven für Leichtathletik (S. 55-70). Hamburg: Czwalina.
- Schöllhorn, W. Michelbrink, M. Welinski, D. Davids, D. (2009) Increasing stochastic perturbations enhance skill acquisition and learning of complex sport movements. In D. Araujo, H. Ripoll, & M. Raab (eds.), Perspectives on Cognition and Action in Sport (pp. 59-73). Hauppauge, NY, United States: Nova Science.
- Schöllhorn, W. I. (2011), Schneller Sprinten und Laufen in allen Sportarten. Schorndorf: Hofmann.
- Schöllhorn, W. I., Sechelmann, M., Trockel, M., Westers, R. (2004). Nie das Richtige trainieren, um richtig zu spielen. Leistungssport, 34, (5), 13-17.
- Schönherr, T., & Schöllhorn, W.I. (2003). Differential learning in basketball. In W.I. Schöllhorn, C. Bohn, J.M. Jäger, H. Schaper, & M. Alichmann (Eds.), 1st European Workshop on Movement Science. Book of abstracts (pp. 58-59). Köln: Sport & Buch Strauß
- Sechelmann, M. & Schöllhorn, W. I. (2003). Differenzielles Training im Fußballpassspiel. In J. Krug & T. Müller (Hrsg.), Messplätze, Messplatztraining, Motorisches Lernen (S. 134-138). Sankt Augustin: Academia
- Schöllhorn, W. I. (1999). Individualität - ein vernachlässigter Parameter? Leistungssport, 29, (2), 7-11.
- Trockel, M. & Schöllhorn, W. I. (2003). Differenzielles Torschusstraining im Fußball. In J. Krug & T. Müller (Hrsg.), Messplätze, Messplatztraining, Motorisches Lernen (S. 102-107). Sankt Augustin: Academia
- Weineck, J. (1998), Das Training der Koordinativen Fähigkeiten im Fussball. In: BDFL Journal 16, 18-21 (Teil 1) und (1999), 17, Doku 3-6 (Teil 2)

Weineck, J. (2003). *Optimales Training: Leistungsphysiologische Trainingslehre unter besonderer Berücksichtigung des Kinder- und Jugendtrainings*. Balingen Wertheim, M. (2000). *Die Ausbildung des Sportlehrers zum Trainer im Wettkampfsport unter besonderer Berücksichtigung der Integration der Trainingswissenschaft*. Leistungssport (2). Germany.

Wertheim, M. (2011). "Koordination-ein Verbund aus Systematik und Fantasie" LSP.

Wertheim, M (2011) Introduction to the Optimal Coordination Order (OCO) System - The Innovative Way for Developing Individual Coordination Ability for Sport Arts ,ICSSPE Bulletin No 61

### **The “state of the art” is presented in :**

Platonov, V.N. (1997). *Obshchaja Teorija Podgotovki Sportsmenov v Olimpichkom Sporte (General Theory of Athletes' Preparation in Olympic Sports)*. Kiev: Olimpiyskaja Literatura.

Good recent handbooks in English for coaches on General Coaching Science/ Theory include:

Crisfield, P., Cabral, P. and Carpenter, F. (Eds.). (1996). *The Successful Coach: Guidelines for Coaching Practice*. Headingley: National Coaching Foundation.

Pyke, F.S. (1991). *Better Coaching: Advanced Coach's Manual*. Canberra: Australian Coaching Council.

Wertheim, M (2004) *Adaptation process to affectivity function in sport* P & P & P ,dr. mark 's series in sport & training ,haifa m & t (Hebrew)/

### **2.3. Book Series**

American Coaching Effectiveness Program. (Champaign, Ill.: Leisure Press 1984-94, Leisure Kinetics 1989-92).

National Coaching Certification Program.(Various places, Various publishers).

Studienbrief der Trainerakademie Köln (Study Letters of the Coaching Academy in Cologne). Schorndorf: Karl Hofmann 1988-present.

### **2.4. Proceedings**

#### **2.5. Databases**

Sport Discus (Sport Information Resource Center, Canada, multilingual).

Atlantes(Instituto Andaluz del Deporto, Spain, in Spanish).

Heracles (Institut National du Sport et de l'Education Physique, France, in French).

Spolit (Bundesinstitut für Sportwissenschaft, Germany, in German).

#### **2.6. Internet Sources**

Coaching & Officiating unit of the Australian Sports Commission (ASC)

[www.ausport.gov.au/participating/coaches](http://www.ausport.gov.au/participating/coaches)

Coaches Corner (Gatorade Sports Science Institute, USA)

[www.gssiweb.com](http://www.gssiweb.com)

Coaching Association of Canada

[www.coach.ca/](http://www.coach.ca/)

Sports Coach (B. Mackenzie, United Kingdom)

[www.brianmac.demon.co.uk/](http://www.brianmac.demon.co.uk/)

United States Olympic Committee – Olympic Coach

[rose.snyder@usoc.org](mailto:rose.snyder@usoc.org) and [peter.davis@usoc.org](mailto:peter.davis@usoc.org)

### **3. Organizational Network**

#### **3.1. International Level**

The International Council for Coach Education (ICCE), represents the various bodies concerned with education of coaches and application of Coach Science/Theory in daily work all over the world. It was founded in 1997. The objectives of the ICCE are to promote Sport Coaching in general, and as a profession in particular, by various means, specifically, by “promoting and utilising research in the field of training and competition”, “exchanging knowledge in the field of coaching”, “disseminating information about curricula, qualifying standards etc.”, “professional publication in the field of coaching education” (ICCE Objectives). In 2002, 21 countries were represented in ICCE, which holds conferences every second year (one year before the summer and winter Olympic Games, in the city in which the Games are to be held).

Other international organizations concerned with sports and physical education, such as AIESEP (Association Internationale des Ecoles Supérieures d'Education Physique), FIEP (Fédération Internationale d'Education Physique), ICHPER-SD (International Council for Health, Physical Education, Recreation, Sport and Dance) and the International Olympic Committee (through the aid it provides by way of the Olympic Solidarity program) all use and promote Coaching Science/Theory as a secondary part of their activities.

The Governing Bodies (International Federations) of the various sports do the same with regard to sports-specific Coaching Science/Theory.

#### **3.2. Regional Level**

The European Union has taken the initiative to design a 5-tier scheme of coaching levels. Many other countries, including Canada have adopted a similar scheme for their National Coaching Certification Program. This scheme provides a framework for the use of Coaching Science/Theory, from the rudimentary stage of the Level 1 Coach up to the academic-degree level of the Level 5 Coach, who utilizes the most sophisticated and advanced facets of Coaching Science.

#### **3.3. National Level**

Several countries teach, advance and promote Coaching Science/Theory in their national sports centers, in which both coach education and top-level sport training is centralized. Examples are:

- Australia, through the Australian Coaching Council;
- Canada, through the Coaching Association of Canada;
- China, in its Coaching Department of the All-China Sports Federation;
- France, in its INSEP (Institute National du Sport et Education Physique);
- Germany, Deutsche Sporthochschule and the Trainerakademie a in Cologne
- Germany , Leipzig University and the Institut für Angewandte Trainingswissenschaft
- Great Britain, through the National Coaching Foundation;
- Hungary, in the Budapest University of Physical Education;
- Israel, Wingate Institute for Physical Education and Sport;
- Switzerland, in its Magglingen Sports Centre in Biel; and
- United States, through its coaching leadership of the Olympic Training Center at Colorado Springs.

In addition, countries are developing Coaching Science/Theory through their Sport Governing Bodies, University Physical Education and Sport Colleges, Sport Institutes etc.

### **3.4. Specialized Centers**

See details under section 3.3 National Level.

### **3.5. Specialized International Degree Programs**

Several universities in the former Eastern Bloc e.g. Kiev, Budapest and Leipzig, educate coaches in a 4-year academic program which includes a thorough grounding in Coaching Science/Theory.

The Level 5 coaching program of the European Union is similar and is carried out in accredited universities. It takes 4 full years and includes 2400 study hours, half of which are general sports science studies and the other half sports-specific studies. In addition, the students must have 2 years of practical coaching experience.

## **4. Appendix Material**

### **4.1. Terminology**

Most of the terminology of "Coaching Science/Theory" has been developed in the countries of the former Eastern Bloc. Today, there is an overall consensus on the terminology, although some inconsistencies and illogicalities remain. As examples, use of the terms "mesocycle" and "macrocycle" differ between different authors; "training means" is sometimes defined narrowly but sometimes very broadly; "training methods" sometimes refers to the spectrum "continuous-interval-repetition" only, while on other occasions it will include the "pyramid" method, "whole" and "part" technical learning methods, etc. In English, "strength" is used in places where "force" would be appropriate, while in German, "Leistung" is used for "power", "achievement" and "performance". The difference between "power", "speed-strength", "strength-speed" and "explosive strength" is often unclear. But these inconsistencies and illogicalities are minor flaws and usually the context makes the meaning abundantly clear.

### **4.2. Position Statement**

"Training & Coaching Science is still a branch of Sports Science, which deals with the theoretical foundations and methodological forming of athletic training, subject to the aim of achieving physical perfection, developing athletic performance as well as success in athletic competition." (Schnabel et al. 1986).

### **4.3. Varia**

Not applicable.

### **4.4. Free Statement**

Training & Coaching Science in general and the education of coaches in particular, are currently helping in the creation of a new profession: Sports coaching, which is coming of age as a fully-fledged profession. As the public today has more leisure time than previously, there is a need to use this time effectively and sensibly. There is a demand of parents, teachers, physicians and the public at large, that care be taken of children's health and well-being, and that they may be enabled to grow and develop according to their gifts and preferences. This necessitates, much more than in the past, that sports coaching be based on moral, scientific and professional foundations and that those engaged in coaching be educated professionally, even academically, in the opinion of some people, just as members of other professions are prepared for theirs.

With rapid developments in information technology, both of software and hardware, coaching education will increasingly turn to various forms of "e-learning" in order to, on one hand, reduce the expenses incurred in coach education and, on the other hand, to provide wider access of students of coaching to the world's leading authorities on the subject. These new methods



of teaching and learning will also serve to disseminate more rapidly and more widely the most recent advances in coaching know-how.

#### **4.5. Update**

New Tendencies in Training Science for Children

1. Scientific focus on and ways of research in children's training.  
Different structures for motor coordination analyze general., specific and in combination with technique  
Ability for coordination under pressure of instability , time , place and complex information  
Ability for coordination under control and adaptation as a process in coaching
2. Training, planning and control in combination with computer sciences, long term planning.
3. Research on competition: From analyzing the performance to simulating the successful strategy.
4. The role of different stimulus and stimulus irritations in training processes
5. The role of intellectual processes increasing as a result of the new tendencies.
6. New ways in the education of coaches' general and special instructors for children.

#### **Contact**

Dr. Mark Wertheim

CENTER FOR COACHING SCIENCE UND COORDINATION

34372 ISRAEL

Phone: +972 4 8333578

Fax :+972 4 8332747

WEB: : [WWW.OCO-GYM.COM](http://WWW.OCO-GYM.COM)

Mail: [ocoinfo@gmail.com](mailto:ocoinfo@gmail.com)