



## **LONG-TERM ATHLETE DEVELOPMENT: TRAINABILITY IN CHILDHOOD AND ADOLESCENCE**

### **Windows of Opportunity, Optimal Trainability**

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Scientific research has concluded that it takes eight-to-twelve years of training for a talented player/athlete to reach elite levels. This is called the ten-year or 10,000 hour rule, which translates to slightly more than three hours of practice daily for ten years (Ericsson, et al., 1993; Ericsson and Charness, 1994, Bloom, 1985; Salmela et al., 1998) Unfortunately, parents and coaches in many sports still approach training with an attitude best characterized as "peaking by Friday," where a short-term approach is taken to training and performance with an over-emphasis on immediate results. We now know that a long-term commitment to practice and training is required to produce elite players/athletes in all sports.

### ***"It takes 10 years of extensive training to excel in anything"***

Herbert Simon - Nobel Laureate

#### **Introduction**

A specific and well-planned practice, training, competition and recovery regime will ensure optimum development throughout an athlete's career. Ultimately, sustained success comes from training and performing well over the long-term rather than winning in the short-term. There is no short-cut to success in athletic preparation. Overemphasizing competition in the early phases of training will always cause shortcomings in athletic abilities later in an athlete's career.

This article discusses trainability during childhood and adolescence. Coaches worldwide currently design long and short-term athlete training models as well as competition and recovery programs based on their athletes' chronological age. Yet, research has shown that chronological age is not a good indicator on which to base athlete development models for athletes between the ages of 10 to 16. There is a wide variation in the physical, cognitive and emotional development of athletes within this age group.

One of the most important periods of motor development for children is between the ages of nine to 12. During this time children are developmentally ready to acquire general overall sports skills that are the cornerstones of all athletic development.

Superimposing a scaled down version of adult athlete training and competition models is not a good alternative either. Ideally, coaches would be able to determine the biological age of their athletes and use this information as the foundation for athlete development models. Unfortunately, there is no reliable procedure to identify biological age non-invasively. So what can be done to remedy this situation?

One practical solution is to use the onset of Peak Height Velocity (PHV) as a reference point for the design of optimal individual programs with relation to "critical" or "sensitive" periods of trainability during the maturation process.

Prior to the onset of PHV, boys and girls can train together and chronological age can be used to determine training, competition and recovery programs. The average age for the onset of PHV is 12 and 14 years for females and males respectively. The onset of PHV is influenced by both genetic and environmental factors, including climate, cultural influences, and social environment.

The onset of PHV is a reference point that provides valuable information for training the athletes' energy systems and Central Nervous System (CNS), regardless of chronological age. Using simple measurements, PHV can be monitored and training can be related and optimized to exploit the critical periods of trainability. This approach can enhance the development of short and long-term individually optimized training, competition and recovery programs such the optimal window of accelerated adaptation to stamina (endurance), strength, speed, skill and suppleness training – or the Five S's of training and performance.

It should be pointed out that all energy systems are always trainable, but during the so-called "critical" periods accelerated adaptation will take place if the proper volume, intensity and frequency of exercise are implemented.

### **The Model of Long-Term Athlete Development**

Sports can generally be classified as early specialization or late specialization sports. Early specialization refers to the fact that some sports, such as diving, figure skating, gymnastics, rhythmic gymnastics, and table tennis require early sport-specific specialization in training.

Late specialization sports, including track and field, combative sports, cycling, racquet sports, rowing and all team sports require a generalized approach to early training. For these sports, the emphasis during the first two phases of training should be on the

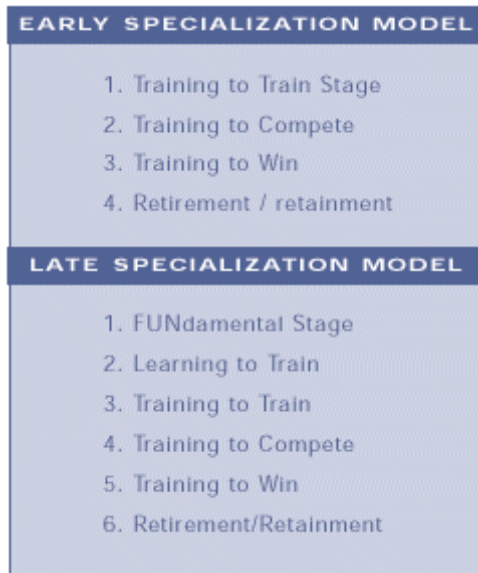
development of general motor and technical-tactical skills. Early specialization sports require a four-phase model, while late specialization sports require a six-stage model:

**Early Specialization Model Late Specialization Model**

- 1. Training to Train stage 1. FUNdamental stage
- 2. Training to Compete 2. Learning to Train
- 3. Training to Win 3. Training to Train
- 4. Retirement / retainment 4. Training to Compete
- 5. Training to Win
- 6. Retirement / retainment

These models are generic in nature and will require adjustment on a sport specific basis.

Since there are only a few sports that can be categorized as early specialization sports, this article focuses on late specialization sports. Each early specialization sport should develop a sport-specific model of its own. A generic model would lead to serious oversimplifications. The challenge for early specialization sports is to find a way to either combine the "FUNdamental" and "Learning to Train" stages or to amalgamate them into a single stage. For late specialization sports, specialization prior to age ten is not recommended since this contributes to early athlete burn-out, drop-out and retirement from training and competition.



**THE SIX-STAGE MODEL OF LATE SPECIALIZATION**

**SPORTS**

**Stage 1 – The FUNdamental Stage TM**

AGE: Males 6 - 9 / Females 6 - 8 years

Objective: Learn all fundamental movement skills (build overall motor skills)

Fundamental movement skills should be practiced and mastered before sport-specific skills are introduced. The development of these skills, using a positive and fun approach, will contribute significantly to future athletic achievements. Participation in a wide range of sports is also encouraged. This emphasis on motor development will produce players/athletes who have a better trainability for long-term, sport-specific development.

Fundamental movement skills are observable as locomotor, manipulative and stability skills. There are three stages of fundamental movement skill development: initial (2-3 years), elementary (4-5 years) and mature (6-7 years).

The "FUNdamental" phase should be well structured and fun! The emphasis is on the overall development of the player/athlete's physical capacities and fundamental movement skills, and the ABC's of athleticism - Agility, Balance, Coordination and Speed. Participation in as many sports as possible is encouraged. Speed, power and endurance are developed using FUN games. Appropriate and correct running, jumping and throwing techniques are taught using the ABC's of athletics.

The first 'window of accelerated adaptation to speed' or 'critical period of speed development' will occur during this phase, age 6-8 for girls and 7-9 for boys respectively.

Linear, lateral and multi-directional speed should be developed and the duration of the repetitions should be less than 5 seconds. This is often called the 'agility, quickness, change of direction' window. Again, fun and games should be used for speed training and the volume of training should be lower.

Strength training during this phase should include exercises using the child's own body weight; medicine ball and Swiss ball exercises. Children should be introduced to the simple rules and ethics of sports. No periodization takes place, but all programs are structured and monitored. Activities revolve around the school year and during summer and winter holidays, multi-sport camps are recommended. If children and parents have a preferred sport, participation once or twice per week is recommended, but participation in other sports three or four times per week is essential for future excellence. If the children later decide to leave the competitive stream, the skills they have acquired during the Fundamental phase will still benefit them when they engage in recreational activities, which will enhance their quality of life and health.



## **Stage 2 – The learning to train stage**

AGE: Males 9 – 12 / Females 8 – 11 years

Objective: Learn all fundamental sports skills (build overall sports skills)

Specialized movement skills are developed from age seven to age eleven, and are specialized sports skills. By passing the fundamental and specialized skill development phase is likely to be detrimental to the child's future engagement in physical activity and sport. Early specialization in late specialization sports can also be detrimental to the proceeding stages of skill development.

One of the most important periods of motor development for children is between the ages of nine to 12. During this time children are developmentally ready to acquire general overall sports skills that are the cornerstones of all athletic development.

This is the 'window of accelerated adaptation to motor coordination'. All fundamental movement skills should be further developed and general overall sports skills should be learned during this phase.

If fundamental motor skill training is not developed between the ages of eight to 11 and nine to 12 respectively for females and males, a significant window of opportunity has been lost, compromising the ability of the young player/athlete to reach his/her full potential.

Strength should be developed by medicine ball, Swiss ball and own body-weight exercises as well as hopping-bounding exercises (or routines). Endurance should be developed further by games and relays. Basic flexibility exercises should be introduced during this phase, while speed can be developed further with specific activities during the warm-up, such as agility, quickness and change of direction. Competition should be well structured. The most suitable framework is single periodization for this phase, however for a few sports, sport-specific needs will warrant double periodization (e.g. swimming, tennis). A 70:30 training/practice to competition-ratio is recommended.

### **Stage 3 – The Training to Train Stage TM**

AGE: Males 12 - 16 / Females 11 - 15 years

Objectives: Build the aerobic base, build strength towards the end of the phase and further develop sport-specific skills (build the "engine" and consolidate sport specific skills).

During the "Training to Train" stage young athletes consolidate basic sport-specific skills and tactics. This phase is a 'window of accelerated adaptation to aerobic and strength training.' Optimal aerobic trainability begins with the onset of Peak Height Velocity (PHV) or the major growth spurt during maturation. Aerobic training should be prioritized after the onset of PHV, while skill, speed and strength should be maintained or developed further. Special emphasis is also required for flexibility training due to the sudden growth of bones, tendons, ligaments and muscles.

There are two windows of accelerated adaptation to strength training for females. Window one is immediately after PHV and window two begins with the onset of menarche (the first menstrual period). This window for males begins 12 - 18 months after PHV.

It should be noted that both aerobic and strength trainability is dependent on maturation levels, thus early, average or late maturers need different timing of the training emphasis. At present most of these decisions are made on chronological age (age groups) and not on individual, maturation level needs.

Single, double and occasionally (depending on sport-specific demands) triple periodization is the optimal framework of preparation during this phase. During competitions athletes play to win and to do their best, but the major focus of training is on learning the basics as opposed to competing. Training and competition ratios are optimized because too many competitions waste valuable training time and conversely, not enough competition inhibits the practice of technical/tactical skills and learning how to cope with the physical and mental challenges presented during competition.

A 60 percent training to 40 percent competition ratio is recommended by experts during the "Training to Train" phase and the 40 percent competition ratio includes competition and competition-specific training. However, these percentages vary according to sport and individual specific needs. Athletes undertaking this type of preparation will be better prepared for competition in both the short and long-term, than those who focus solely on winning. During this phase, athletes train in competitive situations daily, in the form of practice matches or competitive games and drills.

The "Training to Train" phase addresses two of the critical or sensitive periods of physical development. Athletes who miss this phase of training will not reach their full potential, as these critical periods have been missed. The reason why so many athletes plateau during the later stage of their careers is primarily because of an over emphasis on competition instead of on training during this important period in their athletic development.

The "Learn to Train" and "Training to Train" stages are the most important phases of athletic preparation. During these stages 'we make or break an athlete!'

#### **Stage 4 – The Training to Compete Stage TM**

AGE: Males 16 - 18 / Females 15 - 17 years

Objectives: Optimize fitness preparation and sport, individual and position- specific skills as well as performance (optimize "engine", skills and performance).

This phase of development is introduced after the goals and objectives of the "Training to Train" stage have been achieved. The training to competition and competition-specific training ratio now changes to 50:50. Fifty percent of available time is devoted to the development of technical and tactical skills and fitness improvements, and fifty percent is devoted to competition and competition-specific training.

During the "Training to Compete" phase, high intensity individual event and position-specific training is provided to athletes year-round. Athletes, who are now proficient at performing both basic and sport specific skills, learn to perform these skills under a variety of competitive conditions during training. Special emphasis is placed on optimum preparation by modelling training and competition. Fitness programs, recovery programs, psychological preparation and technical development are now individually tailored to a greater degree. This emphasis on individual preparation addresses each athlete's individual strengths and weaknesses. Double and multiple periodization is the optimal framework of preparation.



### **Stage 5 – The Training to Win Stage TM**

AGE: Males 18 years and older / Females 17 years and older

Objectives: Maximize fitness preparation and sport, individual and position specific skills as well as performance (maximize “engine”, skills and performance)

This is the final phase of athletic preparation. All of the athlete’s physical, technical, tactical, mental, personal and lifestyle capacities are now fully established and the focus of training has shifted to the maximization of performance. Athletes are trained to peak for major competitions. Training is characterized by high intensity and relatively high volume. Frequent “prophylactic” (preventative) breaks help to prevent physical and mental burnouts. Training to competition ratio in this phase is 25:75, with the competition percentage including competition-specific training activities.

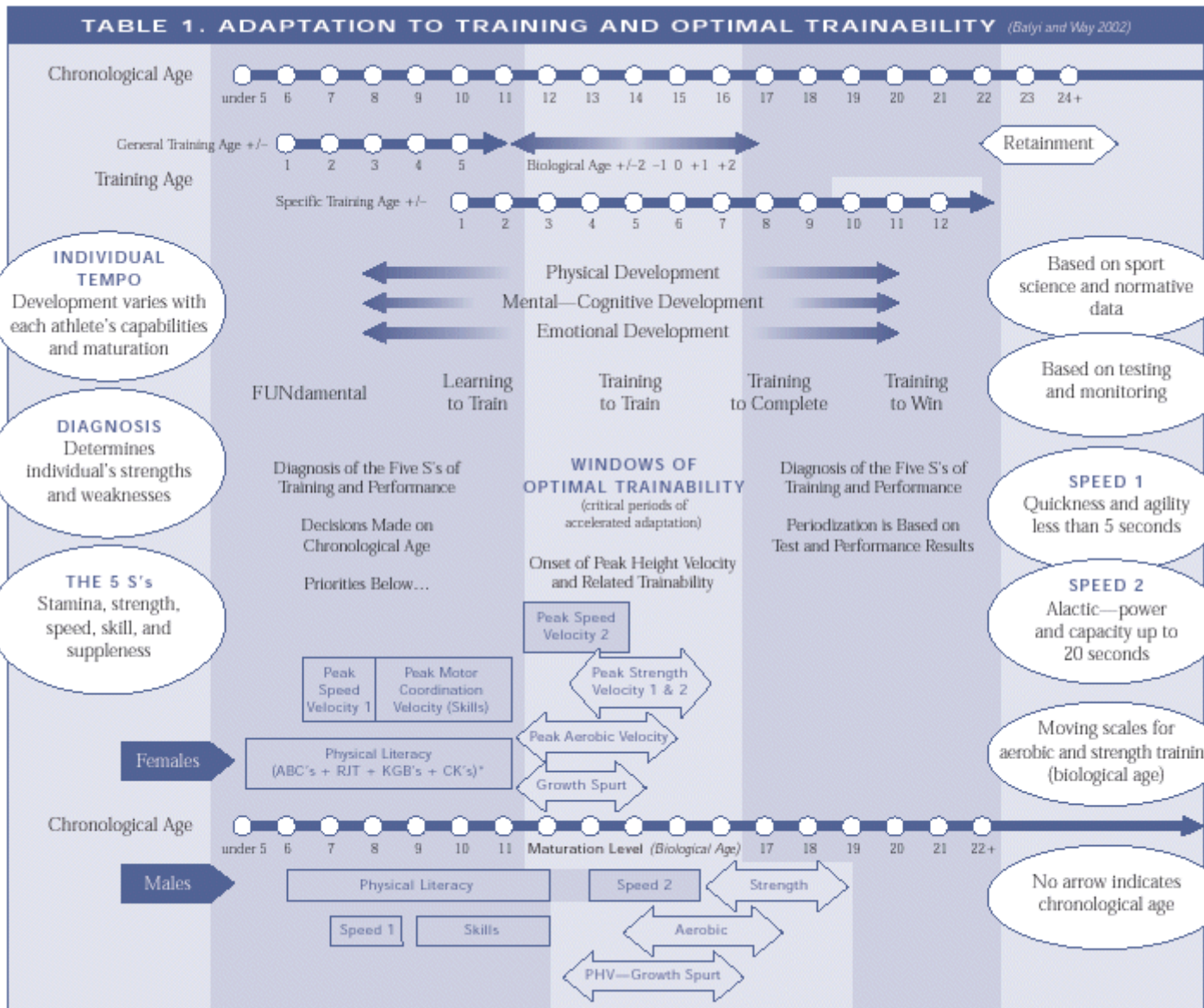
### **Stage 6 – The Retirement / Retention stage**

Objectives: Retain athletes for coaching, administration, officials, etc.

This phase refers to the activities performed after an athlete has retired from competition permanently. During this final phase, some ex-athletes move into sport-related careers that may include coaching, officiating, sport administration, small business enterprises, master’s competition, media, etc.

Table One, (Appendix One) provides a generic outline of trainability. It identifies the various windows of trainability, showing chronological age, general and specific training age, the five stages of long-term athlete development, trainability windows and the moving scales of aerobic and strength trainability during the maturation period.

In this table, no arrow indicates chronological age, while arrows indicate moving scales, depending on the onset of PHV. Before the onset of PHV, and after maturation (post puberty) simple testing can determine training priorities, taking into consideration the windows of accelerated adaptation to training. This generic table can easily be adjusted to sport-specific norms and demands.



\*ABC's = Agility Balance Coordination Speed + RJT = Run Jump Throw + KGB's = Kinesthesia Gliding Bouyance Striking with objec + CK's = Catching Kicking Striking with body

## SELECTED BIBLIOGRAPHY

This article is based on the presentation given at the Scottish Strength and Conditioning Seminar in Largs, in May 2003.

Alpine Integration Model. Alpine Ski Canada, 1999.

Anderson, G.S., and Bernhardt, B.A. Coaching Children. Growth and Maturation Considerations. BC Coaches' Perspective. Fall, 1998. Vol.2. Issue. 4. pp.14 - 16.

I. Balyi: "Sport System Building and Long-term Athlete Development in Canada. The Situation and the Solutions." In Coaches Report. The Official Publication of the Canadian Professional Coaches Association, Summer 2001, Vol.8, No.1, pp.25-28.

Bar-Or, O. ed., The Child and Adolescent Athlete. London: Blackwell Scientific Publications, 1996.

Blimkie, C.J.R. and Bar-Or, O. "Trainability of Muscle Strength, Power and Endurance during Childhood". In: Bar-Or, O. ed., The Child and Adolescent Athlete. London: Blackwell Scientific Publications, 1996.

Bloom, B. Developing Talent in Young People. New York: Ballantines, 1985.

Building Pathways in Irish Sport. National Training and Coaching Centre, Ireland, 2003.

Ericsson, K.A. and Charness, N. Expert performance. Its structure and acquisition. American Psychologist, August 1994, p. 725-747.

Ericsson, K.A., Krampe, R.T. and Tesch-Romer, C. The role of deliberate practice in the acquisition of expert performance. Psychological Review, 1993, p. 363-406.

Malina, R.M. and Bouchard, C. Growth, Maturation, and Physical Activity. Champaign, IL.: Human Kinetics, 1991.

Ross, W.D. and Marfell-Jones, M.J. Chapter 6. Kinanthropometry. In MacDougall, D.J., Wenger, H.A. and Green, H.J. Physiological Testing of the High-Performance Athlete. 2nd Edition. Champaign, IL.: Human Kinetics, pp.76-115.

Rowland, T. Developmental Exercise Physiology. Champaign, IL.: Human Kinetics, 1996.

Rushall, B. The Growth of Physical Characteristics in Male and Female Children. In: Sports Coach, Australia. Vol. 20., No.64, Summer, 1998. pp. 25-27.

Salmela, J.H., Young, B.W. and Kallio, J. Within-career transition of the athlete-coach triad. In Wylleman, P. and Lavallee, D., (Eds.) Career transition in :. Morgantown, VA: Fit Publications, 1998.

The Swimmer Pathway. Amateur Swimming Association. England. 2003.

Viru, A. Adaptation in Sports Training. London, CRC Press. 1995.

Viru, A., Loko, J., Volver, A., Laanetos, L., Karelson, K., and Viru, M. Age Periods of Accelerated Improvements of Muscle Strength, Power, speed and endurance in the Age Interval 6-18 Years. In Biology of Sport (Warsaw) Vol. 15(4), 1998, pp. 211-227.

Vorontsov, A.R. Patterns of Growth for Some Characteristics of Physical Development: Functional and Motor Abilities in Boy Swimmers 11 – 18 Years. In: Biomechanics and Medicine in Swimming VIII, eds. Keskinen, K.L., Komi, P.V. and Hollander, A.P. Jyvaskyla, Gunners, 1999.