



Volume 1: Biathlon Canada LTAD Model



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Canada

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Preface and Acknowledgments

"Sport is a continuum from the local club level to the national team at the apex of its discipline. Success at the highest level depends upon the strength of the whole continuum."

Federal White Paper on Sport (1979)

The link between grassroots development and high level international performance has been well known for many years. In the mid 1980's, Biathlon Canada produced an Athlete Development Model (ADM) as a guide for coaches and athletes who were interested in progressing through this continuum to the national team. That document, prepared by Paul Imrie, Nancy Biggar, Jim Carrabre, Veli Niinimaa, and Bernard Voyer would serve as a guide for coaches through three Quadrennial periods in our Sport (1986-1998).

In 1999, using his NCCP (National Coaching Certification Program) Level 5 - Task 16, Long Term Athlete Development (LTAD) assignment as a springboard, Roger Archambault led a second wave of dedicated coaches (Nelson Ayotte, Paul Dorotich and Darren Grosky) in the development of a stronger and more current Athlete Development Model (ADM) based on the systematic practices employed by many of the leading nations in the sport of Biathlon. In addition to Sport Science, Human Growth and Development principles and Canadian Biathlon historical data, successful practices from nations such as Germany, Norway, France, Austria, Czech Republic, and Finland were researched and consulted in the formulation of the 1999 Athlete Development Model.

The release of the new ADM for Biathlon in 1999 served as the foundation for a paradigm shift - the development of a long term vision for international podium success for Biathlon Canada. This represented a major initiative towards making the vision of an integrated program become reality. This new, more formal LTAD model, was designed to provide coaches with an overview of the Physical, Technical, and Psychosocial skills progression that would carry young athletes from their first introduction to Biathlon in their home clubs all the way to the podium on the international stage.

In 2005, Biathlon Canada, in partnership with Sport Canada, decided to develop a more comprehensive Athlete Development Model. This new model would not only provide a road map from the first experience of Biathlon in a club to international success for an athlete, but also inform coaches, parents, club officials, volunteers and educators of the importance of human growth and development as a context to the implementation of systematic athlete development nation-wide. The 1999 model did not provide the developmental perspective required to ensure that every child is seen, first as a potential participant in sport, then in Biathlon and then potentially in elite Biathlon, bridging the gap between childhood and "athlete-hood" that has been absent in past Biathlon Canada developmental models.

The Biathlon Long Term Athlete Development Model presented here was edited by Dr. Alan Ball and is based on research currently available in the sport medicine literature. The model was heavily influenced by the work of Dr. Istvan Balyi, University of Victoria, on long term athlete development models.

Additional theoretical background and practical insights were contributed by Dr. Stephen Norris, University of Calgary and Dr. John Dunn, University of Alberta. Direction, review and feedback was provided by Roger Archambault, Technical Director, Biathlon Canada.

The ADC review panel: Daniel Lefebvre, Richard Boruta and Geret Coyne, National Training Centre Coaches and Paul Dorotich, Technical Director, Biathlon Alberta provided feedback based on data collected from the Biathlon Canada Training Centres in Canmore and Valcartier.

Acknowledgements:

Biathlon Canada would like to thank all who were involved in pioneering this systematic approach, from the original group who published the Association's initial ADM in the mid 1980's to the following members of the 2005 Athlete Development Committee. All of these contributors have been an integral part in the development of the new Long Term Athlete Development Model for Biathlon Canada.

2005 Biathlon Canada Athlete Development Committee

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Executive Summary

Introduction

This document is Volume 1: The Biathlon Long Term Athlete Development Model (LTADM). It has a companion volume, published separately as Volume 2: The Biathlon Long Term Athlete Development Program (LTADP). This is a summary for Volume 1.

- Components of athletic ability should be encouraged at all ages.
- Athletic abilities should be trained when a particular capability is most sensitive to development and training.
- Training schema must be linked to physiological age to fulfill this second premise.
- Adult athletic capabilities, which are not manifest until puberty or later, should not be trained in child athletes.

Part 1: Human Developmental Stages, Child to Adult: Key Trends

Physical Development:

Growth Rates:

- Between the ages of 4 and 11, boys and girls grow and change steadily and in the same way.
- Between the ages of 4 and 11 boys and girls overlap considerably in size distribution.
- Between the ages of 10 and 15, boys and girls manifest a growth spurt and enter puberty.
- After puberty, growth diminishes steadily to zero.

Puberty:

- Peak Height Velocity (PHV) is the obvious external marker for the pubertal transformation.
- Children aged 11 – 15 show large variations in size, growth rate and physiological development within age groups due to the asynchronous onset and progression of puberty.
- Children transiting through puberty, aged 11 – 15 show correspondingly large differences in sport performance within age groups.

Young Adulthood:

- After puberty, males and females stabilize into statistically separate populations on sexually dimorphic characteristics.
- After puberty, relative statistical homogeneity on physical and physiological capabilities is restored within the male and female populations.

Mental and Neuromuscular Development:

Performance:

- Boy's and girl's athletic abilities change steadily and in essentially similar ways between ages 4 and 11.
- Most of the fundamental athletic and sport skills should normally be in place before puberty.
- Male and female populations overlap significantly on most mental characteristics important to sport performance.
- Perfection of technique via learning from external feedback is not available until late childhood.

Skills:

- Kinesthetic skills are best developed before puberty.
- Mental skills can be trained after ages 4-5, mature slowly and peak sometime after puberty.
- Ongoing development of language skills is key to continued development of mental skills.

Changes in Physical Capabilities Before and During Puberty:

- The opportunity to optimise fundamental athletic capabilities occurs before puberty.
- Fundamental sport skills should be trained before puberty to take advantage of this sequential expression of genetic potential.
- Males and females go through significant physiological changes once puberty sets in.
- Some windows of optimal opportunity for physiological change close and others open.
- The pattern of these changes is strikingly similar for both genders, although chronologically asynchronous, as it is for individuals.
- The opportunity to perfect performance related capabilities occurs during and mostly after puberty.
- The timing and duration of the windows of opportunity are dependent on both PHV and transit time.

Training Effects During Development:

- When training modes are matched to developmental opportunities, athletic development is optimised.
- Only trainable capabilities can be optimized in this way.



Part 2: Growth, Development and Sport

Recreational Sport vs. Elite Performance

Mission Statements:

- Biathlon Canada will achieve consistent international podium performance by leading, promoting, developing and governing biathlon in Canada to the highest standard of excellence.
- The purpose and focus of all our programs, services and action is directed at the holistic development and support of the athletes and their performance.
- Only a small minority of the athletes affected by the Biathlon Canada LTAD are mature, elite performers.
- Competition is necessarily at the core of the Biathlon LTAD

Competition as Play:

- Sport is playful competition. Programs based on this LTAD should preserve this principle into adulthood.
- The reward system is intrinsic to the atmosphere and behaviour that supports this sense of play in sport.

Appropriate Competition Styles for Developmental Stages:

- Children's sport competition must be play-like, engaging, fun, participatory and group or team oriented.
- Competition for pubertal athletes should be based on competition between athletes with similar, matched, performance characteristics.

- Competition for recreational athletes should be based on competition between athletes with similar performance characteristics.
- Elite athletes should compete at the level that is at the edge of their personal performance envelope.
- Appropriate competition structure(s) and the competition reward system are crucial for young adults.

Selection by Predictive Testing:

- In a late maturing endurance sport, predictive testing of young children holds out small hope for success in talent identification.
- Predictive testing may be useful for talent ID in mid to late pubertal athletes who have acquired appropriate endurance sport skills from other sports.

Competition as a Talent Identification Tool:

- In late maturing endurance sports like Biathlon, post pubertal selection by competition is most likely to identify the elite.
- In late maturing endurance sports, selection based on competition performance is not appropriate for pre-pubertal and pubertal children.

Selection by Election:

- The LTAD Program should provide opportunities for exposing large numbers of children to Biathlon.
- The LTAD Program should provide for asynchronous recruitment and suitable competition opportunities for cross-over athletes.

Maturation Phases vs. Sport Development Phases

Sport Skills vs. Developmental Stage:

- Skills and abilities should be taught and trained only at the appropriate times in an individual's sport career.

Biathlon Skills vs. Developmental Stage:

- The best opportunities for training the athletic skills underlying shooting and skiing occur before puberty.
- Physical skills for shooting and skiing should be trained by late childhood, before puberty.
- Physical capabilities necessary for elite competition train best in late puberty or early adulthood.
- Mental skills that support elite competition, such as goal setting, commitment, patience, etc. only mature gradually during the transition into adulthood.

Part 3: Biathlon Skills and Developmental Chronology

This section documents the chronological opportunities for training skills and physiological characteristics for Biathlon. This is laid out in table form with a rating scale (1 to 4) used to indicate optimal training opportunities.

Shooting Skills vs. Development Stage

This section documents the chronological opportunities for training various shooting skills. This is laid out in table form with a rating scale (1 to 4) used to indicate optimal training opportunities.

- The basic shooting skills needed to compete in Biathlon are clearly available by Late Childhood.
- The basic shooting skills needed for biathlon should be trained before Early Puberty.
- Children have the basic shooting skills needed to participate in summer or winter biathlon.
- Shooting training should be timed to the windows indicated by the range 1-4 in the table.
- Firearm regulations and safety concerns are a barrier to training lots of children in biathlon.

Skiing Skills vs. Development Stage

This section documents the chronological opportunities for training various skiing skills. This is laid out in table form with a rating scale (1 to 4) used to indicate optimal training opportunities.

- The basic running, bounding and skiing skills needed for Biathlon should be trained before Late Childhood.
- Children have the basic physical skills needed to participate in summer or winter biathlon.

Mental Skills vs. Developmental Stage

In this section, mental skills are subdivided into various sub-skills in order to illustrate the developmental chronology. The tables represent a broad spectrum of skills that might be subdivided into more or fewer sub-parts. While the end purpose of the skiing and shooting development processes are self-evident, the goal of mental training is to provide the athlete with the tools to master the 3 P's while performing the other two skill sets.

- Most mental skills take a long time to mature, although some are available early.
- Children have the level of mental skills needed to participate in non-competitive summer or winter biathlon.
- Most mental skills needed for participation in biathlon can be trained before Early Puberty.
- Mental training should be timed to the windows indicated by the range 1-4 in the table.
- Mental skills required for elite performance are largely learned skills, and only available in older athletes.

Bibliography

Appendix 1: Community Sport and Elite Athlete Development

Appendix 2: Summary of Training Recommendations Based on Growth and Development

Appendix 3: The Role and Nature of Competitions in the Developmental Phases of LTAD



Les Clegg

Biathlon Long Term Athlete Development Model

Introduction

The purpose of this document is to provide the research background and the theoretical foundation for a long-term athlete development program for Biathlon in Canada. This part of the program is the Long Term Athlete Development Model (LTADM). The model provides the framework within which to develop and deploy a Long Term Athlete Development Program (LTADP). The LTADP is described separately.



Les Clegg

The purpose of this project was to build an athlete development model for biathletes that was congruent with the developmental stages that humans go through as they grow up. Our premise was that athletic development would be optimized if activities and training were closely aligned with the growth opportunities offered by the developmental process.

Part One is a review and synthesis of the information available on the long-term development of children as they progress from early childhood, through puberty and young adulthood to maturity (see below for more detail). In Part Two this information is filtered to focus on those aspects of development that are most relevant to athletic performance and training for sport, including the competition and selection systems. Aspects of physical, mental, social and skill development are addressed. This background information is then reassessed and filtered for the context of Biathlon.

Biathlon, combining cross country skiing with small bore shooting, is an endurance sport with high and contrasting skill content. Participants take many years to develop into mature performers. Aspects of the Biathlon sport system are addressed in this context, including early development of athletic abilities and skills, development of Biathlon-specific skills, talent identification and competition structures.

In Part 3, the optimal sequence(s) in which athletes could acquire the physical, mental, social and technical skills necessary for elite performance in Biathlon are addressed. Tables are provided for physiological and mental development as well as for athletic skills, shooting skills and skiing skills. The sequence and timing of training are based on the information available on the developmental sequences reviewed in Part One. These tables provide the optimal timetable and framework for the Long Term Athlete Development Program (LTADP).

Background

Atko Viru and his colleagues provided the foundation for the LTAD literature in their article, Age Periods of Accelerated Improvement of Muscle Strength, Power, Speed and Endurance in the Age Intervals, 6 – 18 Years, published in 1998. This definitive paper is a meta-study. It collected, analyzed and synthesized the results from 31 peer-reviewed articles and 11 reviews on periodical changes in children and adolescents during development. This dense and closely reasoned paper firmly established that there really are “windows of opportunity” during development in which various physiological capabilities improve preferentially. A more accessible overview is contained in the article by Borms, The Child and Exercise: An Overview, published in 1986, which is reviewed and made more accessible in The Growth of Physical Characteristics in Male and Female Children, Brent Rushall, Sport Coach, 20(4), 1998.

By the early 1990's this information had found its way into advanced text books: Growth Maturation and Physical Activity, Robert M. Malina and Claude Bouchard, 1991 and academic compendia: The Child and Adolescent Athlete, Encyclopedia of Sport Medicine, Vol 6, 1996. Although these findings on physical development were apparently systematically incorporated into sport training in the communist block, these principles and ideas were not strongly articulated or widely incorporated into sports programs in the west until much later.

The literature on psychological development is more diffuse than that available for physical and physiological development. The subject area is much larger, ranging from skill development to socialization, and there doesn't appear to be a definitive article that synthesizes or crystallizes the field. The contribution of Maureen Weiss is notable: Developmental Sport and Exercise Psychology: A Lifespan Perspective, 2002.

The ideas behind long-term athlete development began to filter into the western sport literature as the cold war wound down and coaches and academics began to filter into the west. In the early 1990's, Istvan Balyi imported these ideas to Alpine Canada's training programs, and his ideas began to diffuse into the Canadian Sport system. In the late 1990's, Canadian sports organizations began to work on long term athlete development models and programs based on scientific principles. Biathlon Canada's ADM, published in 2000, was one of the first. Meanwhile, Istvan Balyi, resident at the University of Victoria, became guru to the British Columbia sport system.

Using BC as a platform, he began developing, articulating and advocating the application of LTAD principles not just to training athletes, but to the development of the whole sport system. These ideas were well-received world wide and his first model, Train-to-Train, Train-to-Compete, Train-to-Win, first presented in 1998, has virtually become a mantra for success in sports.

The broad influence of Balyi's ideas can be seen in the recent LTAD's that come out of the United Kingdom and in current developments in Canada. Others have also made significant contributions to this evolution, for example, Vorontsov through the UK Swimming Association, and Salmela and Durand-Bush, through Gymnastics Canada. Popularization of the ideas continues through articles such as those by Sheila Robertson and Richard Way.

Terminology

Like every field of endeavour, this one has its share of jargon, slogans and popularizations. In the tables and discussion of how this information on child development can be applied to Biathlon, we decided to use terminology that links more directly to developmental phases rather than to age groups: Mid Childhood, Late Childhood, Puberty, Young Adult, Adult. It is difficult to avoid defining these terms as statistical age ranges, but using words takes the focus away from the statistical definition and instead, puts the emphasis on the developmental phase.

It is clear from the literature that various windows of opportunity coincide with various stages in development. It is also clear that individual development is not synchronised within age groups, to the point where, especially during puberty, training programs designed for children at one stage of development would probably be ineffective for the development of other children in the same age group who are not at that stage. We have emphasised developmental stage to foster a more radical approach to developing sport programs – one that is more in tune with the developmental process and less focussed on age categories.

We have also tried to avoid a separation between the athletes who perform at exceptional levels (Olympians, elite athletes) and recreational athletes (children, students, weekend warriors, retired elite athletes). All of them start out as children, and they all go through similar stages of development, both physiologically and in terms of learning how to do sport. The difference in performance level changes the details and the commitment at the program level, but not the underlying model that guides these processes.

Nevertheless, we acknowledge the need to market these ideas and to capture them in easily remembered terminology. To be useful and effective, the LTAD ideas must be understood by a wide audience, both inside and outside the sport establishment. Balyi's original terminology and subsequent evolutions serve this need quite admirably (below).

Balyi's Stages

Balyi uses the following hierarchy of terms to describe sport progressions for endurance sports like Biathlon, where athletes reach peak performance as adults:

Active Start: Very early childhood

Nurturing, play and games that foster repetitive rehearsal and learning. Foundations for the ABC's. This is the stage in which movement patterns evolve from child-like to adult-like. Active nurturing, to pre-school and kindergarten. Repetition: running, jumping, tumbling, wrestling, throwing, falling and trying again.

FUNdamentals: Early Childhood

Play and games that foster repetitive rehearsal (FUN) are the key developmental strategies. The stage at which children learn the fundamental skills that support athletic performance: the ABC's (Agility, Balance, Coordination, Speed), RJT (Run, Jump, Throw) and the neurological and mental skills necessary for adult movement patterns. Language skills and the social development necessary to group play also develop.

Learning to Train: Late Childhood

This is the time where children can be introduced to more formal forms of play, including child-adapted adult sports. The stage at which children elaborate on earlier physical skills to develop KGBS (Kinesthesia, Glide, Buoyancy, Striking with implement) and CPKS (Catching, Passing, Kicking, Striking with hand). Neurological, neuromuscular and mental development continues. Children in this stage will enjoy formal practice sessions aimed at developing particular sport skills. Exposure to a variety of sports that encompass KGBS and CPKS is required for long term athletic success. The elements of play and games is still essential to development at this stage.

Training to Train: Early and Mid Puberty

This is the stage where practicing for sport becomes a more formalised activity. It is the point at which boys and girls begin to diverge both in chronology and in physiological and psychological characteristics key to sport. Pubertal children begin to compete for supremacy, to discover and establish their place in the pecking order. Organised sport will be used to this end by the participants. It is a time of rapidly changing abilities and psychological instability.

From a sport perspective, pubertal children are at a stage where they can be taught how to train, and where this training can be used to build on developmental windows of opportunity. Sport

training can also be used to direct development into avenues that will build self-confidence, which leads to life long benefits. Unfortunately for the sport system, boys and girls, both as individuals and as genders, enter and progress through these stages at different times.

Training to Compete: Late Puberty, Young Adult

The stage in sport development where training is more focused on learning competitive skills and less on learning to train. Training becomes more intense and focused on performance characteristics. Adolescent and adult biathletes who participate in Biathlon part time or for recreation may remain in this stage for some years.

Children who are progressing towards elite performance in Biathlon will be invited to participate in enriched athletic programs at Provincial and National levels. They will be trained in advanced competitive skills: physical, mental, technical, and tactical. Development of raw athletic ability will begin to peak and the emphasis will shift towards development of elite sport performance in competition.

Training to Win: Adult

Typically elite athletes close to the pinnacle of their careers. Training is intense, year-round and focused on refining competitive skills to the point where the athlete can consistently perform at the elite level in competitions. Training is for performance on demand, rather than to increase raw athletic or technical ability. Dedicated recreational athletes may also reach this phase at lower performance levels, e.g. Masters National Championships, Masters World Championships.



Les Clegg

Part 1: Human Developmental Stages, Child to Adult: Key Trends

Introduction

The chronology of human development, from early childhood to early adulthood is the framework for all subsequent sections in the Biathlon LTAD model. The model is based on the following premises:

- Components of athletic ability should be encouraged at all ages.
- Athletic abilities should be trained when a particular trait is most sensitive to development and training.
- Training schema must be linked to physiological age to fulfill this second premise.
- Adult athletic capabilities, which are not manifest until puberty or later, should not be trained in child athletes.

An extension of this position is the thought that people who become better at physical activities are more likely to persist with sport into their adult lives. Appropriate training should lead to greater adult retention in sport.

What follows is a survey of the salient developmental characteristics that underlie athletic ability from a chronological perspective. The primary external manifestation of physiological development (age) is growth rate.

Physical Development

Growth Rates

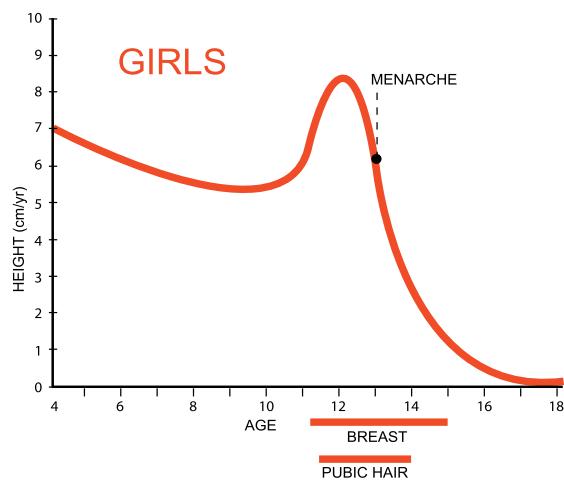
Growth rates vary considerably during a person's life cycle. In general, the growth pattern is the same for males and females, although there are some differences in timing and duration, particularly around puberty. The trends described below are derived from longitudinal and cross sectional studies of large numbers of children. The graphs and numbers represent statistical norms. Most of these studies were done before 1960 and reflect biological reality influenced by the social milieu and lifestyle of children in the mid 20th century.

Growth rate is highest immediately after birth. It declines rapidly over the next two years and then stabilizes at a low rate of decline. Children aged 4 – 11 grow steadily. Those that are larger in size at age 2-3 will be proportionately larger at ages 10-11. The size distribution of boys and girls, as in many other physical and mental characteristics, overlaps considerably during this time period.

- Between the ages of 4 and 11, boys and girls grow and change steadily and in the same way.
- Between the ages of 4 and 11 boys and girls overlap considerably in size distribution.
- Between the ages of 10 and 15, boys and girls manifest a growth spurt and enter puberty.
- After puberty, growth diminishes steadily to zero.

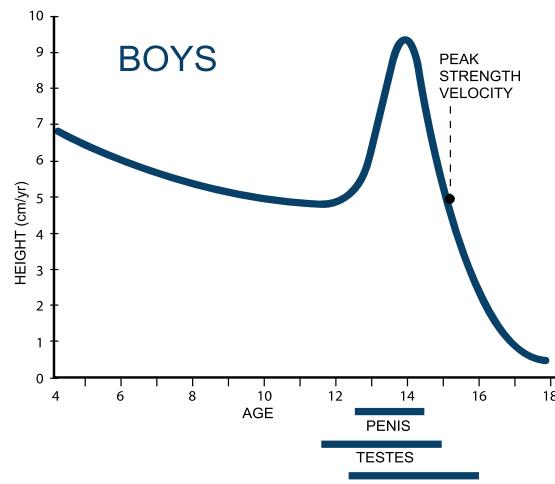
Maturity Events in Girls (Modified after Ross et al.1977)

PHV in girls occurs at about 12 years of age. Usually the first physical sign of adolescence is breast budding, which occurs slightly after the onset of the growth spurt. Shortly thereafter, pubic hair begins to grow. Menarche, or the onset of menstruation, comes rather late in the growth spurt, occurring after PHV is achieved. The sequence of developmental events may normally occur 2 or even more years earlier or later than average.



Maturity Events in Boys (Modified after Ross et al.1977)

PHV in boys is more intense than in girls and on average occurs about 2 years later. Growth of the testes, pubic hair, and penis are related to the maturation process. Peak Strength Velocity (PSV) comes a year or so after PHV. Thus, there is pronounced late gain in strength characteristics of the male athlete. As with girls, the developmental sequence for male athletes may occur 2 or more years earlier or later than average. Early maturing boys may have as much as a 4-year physiological advantage over their late-maturing peers. Eventually, the late maturers will catch up when they experience their growth spurt.



Puberty

Puberty is the time when children begin to produce the hormones that transform their bodies and minds into their adult forms. This change has profound physiological implications and therefore is of profound importance to sport performance. This change is signaled by an increase in growth rate. This pubertal growth spurt is characterized by a "Peak Height Velocity", PHV – the point of fastest growth. The PHV can be used as a marker to determine the hormonal state of teenagers. After puberty, growth rate drops steadily towards zero.

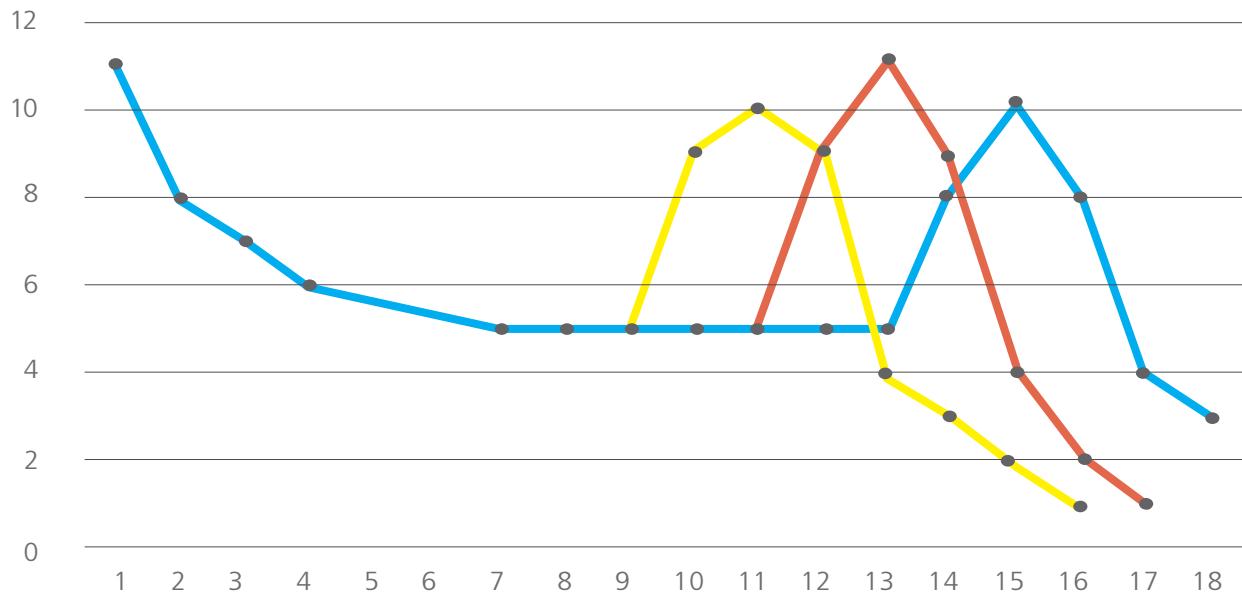
- PHV is the obvious external marker for the pubertal transformation.

The PHV marker is very important in the LTAD context. Different individuals start into puberty at different chronological ages.

Some individuals go through puberty very quickly, some very slowly. Statistically there seems to be three patterns: fast, average and slow. A fast transition can be as little as eighteen months. A slow transition can take up to five years. This combination of early and late starters with fast to slow transitions breaks up the statistical uniformity of the late childhood population. Suddenly, a group of children of the same chronological age exhibit a huge range of physiological ages.

- Children aged 11 – 15, show large variations in size, growth rate and physiological development within age groups due to the asynchronous onset and progression of puberty.
- Children transiting through puberty, aged 11 – 15 show correspondingly large differences in sport performance within age groups.

Peak Height Velocity - Early, Average and Later Maturers - Female



Young Adulthood

During puberty, the difference between males and females becomes more obvious. Males are generally bigger and develop greater amounts of lean muscle mass. As a result, males tend to be stronger and faster than females. However, there is still considerable statistical overlap between the male and female populations on these and other athletic characteristics. As the population gradually shifts out of puberty, the statistical variance within the male and female populations lessens, and gender-based statistical norms once more become useful in planning for sport training and development.

These changes, charted in the general population, apply equally well to potential elite athletes.

The physical transition from Young Adult to Adult may take another two to five years post-puberty. This is a significant factor in late-development endurance sports like Biathlon.

- After puberty, males and females stabilize into statistically separate populations on sexually dimorphic characteristics.

After puberty, relative statistical homogeneity on physical and physiological capabilities is restored within the male and female populations.

Mental and Neuromuscular Development

The stable growth rate exhibited in mid and late childhood is accompanied by a general transformation of mental, physical and neuromuscular patterns towards adult forms of movement. The evidence is based mostly on chronological snap shots, rather than longitudinal studies. This stable development phase ends at puberty.

Movement

The development of some simple athletic abilities illustrates the gradual change in gross motor skills during childhood. Start, in this context, means that the activity is recognizable; Mature means that the movement contains the essential elements of the adult movement (not adult performance). These skills require the development of coordination and neuromuscular patterns across multiple joints and/or multiple upper and lower limbs.

The neuromuscular development includes central nervous system learning as well as developing limb-based reflexes. The immature forms of these movements often bear no resemblance to the mature versions, implying considerable neural and neuromuscular learning during development.

Also striking is the early age at which most of the activities studied reach the mature form, as well as the range of years over which these changes take place. This is discussed further in a sport context below.

Boys: Activity	Start (yrs after birth)	Mature (years after birth)	Number of years
Throwing	<1	5	5
Running	2	4	2
Jumping	2	9.5	7.5
Hopping	2.5	7.5	5
Skipping	4.5	6.5	2

Malina, R. M. and Bouchard, C, Growth, Maturation and Physical Activity, p.180, Human Kinetics, 1991

Performance

Performance, as compared to the form of movement, also matures through mid to late childhood. Research on speed and accuracy development in children, using target-tapping tasks, reveals that both accuracy and speed increase with age (4 - 10/11). The performances of boys and girls are very similar on these tasks. An interesting sub-finding of this research is that for ten and eleven year olds, the tapping score goes up if the children do multiple trials – that is, ten year olds exhibit skill improvement, learning from the trials, i.e. from practice. There is no practice improvement in younger children on the kinds of tasks where performance feedback is useful.

For motor performances dependent on eye-hand coordination, reflex speed and feedback learning, there is a gradual increase in coordination and speed, followed by incorporation of learning from multiple trials towards the end of childhood.

- Boy's and girl's athletic abilities change steadily and in essentially similar ways between ages 4 and 11
- Most of the fundamental athletic and sport skills should normally be in place before puberty.

There doesn't appear to be a clear mental marker, like PHV, that signals onset of a mental transition from child to adult. There are significant differences between different age groups, but the mental transformation seems to be more gradual and only loosely coupled to the physical transformation.

Children under the age of eight or nine are very poor judges of their own prowess (at least in adult terms). Psychological studies show that young children rely on external sources - parents, coaches, teachers, for these judgments. The same studies indicate that children associate effort with success. In mental training terms, children use a mastery model for self-evaluation and measuring success. They associate success with effort made rather than some form of external ranking.

As children enter puberty, this attitude changes and they become much more outcome oriented, shifting their self-worth judgments from an assessment based on internal effort to an assessment based on external comparison with peers. At this time, children begin to differentiate between effort and ability as measures of athletic performance. Although one can perhaps understand the evolutionary value of ranking judgements, re: mating rituals, from a performance perspective, this is not necessarily a good thing.

From a sport perspective, pubertal athletes default to performance-based external ranking as their model for judging self worth. They have a hard time focusing on mastery as a measure of self worth. This mental change in perspective coincides with a time of diverse physiological development rates and performance outcomes.

This is unfortunate, as adults who are successful athletes focus almost entirely on mastery as a measure of success and self worth. However, most young adults grow out of the tendency to use external rankings as a means for measuring self worth of their own accord.

- Male and female populations overlap significantly on most mental characteristics important to sport performance.
- Perfection of technique via learning from external feedback is not available until late childhood.

Skills

There is not much to add under this heading. Skill learning requires that the underlying physical abilities be present and that the athlete posses the neural and neuromuscular abilities needed to learn the skill (see above).

The next component is the ability to learn from feedback. Learning of gross motor skills appears to rely more on kinesthetic feedback than on higher neural processing skills, although there are competing models in the literature. Some learning based on feedback is demonstrated in the target-tapping example by eight to eleven year olds.

From a sport perspective, it appears that kinesthetic ability develops first, primarily through the ages 2–10 and that it is during this period that children learn fundamental athletic skills. It is also the time at which they are most likely to be able to learn more complex, kinesthetic-based sport skills, like the 3-D skills of gymnastics, or

balancing on a moving platform, as in skating, bike riding or snow sliding.

- Kinesthetic skills are best developed before puberty.

Children at ages ten to eleven can form basic mental models. The mental modeling and abstract thinking needed for more complex sport skills appear only in late childhood, maturing through puberty and early adulthood.

More complex sport skills, like sequence shooting, course segmentation, strategies, tactics, mood manipulation, commitment, etc. are paced by the development of abstract thinking.

- Mental skills can be trained after ages 4–5, mature more slowly and peak sometime after puberty.
- Ongoing development of language skills is key to continued development of mental skills.

Windows of Opportunity

The next section addresses the relationship between changes in physical characteristics due to growth and the opportunities to affect performance outcomes through targeted training.

The following table of sport related capabilities was compiled by Andrei Vorontsov (British Swimming) from research done by Schramm et al, 1984, presented to the BC Swimming Coaches Conference, October 2002 in Vancouver. It illustrates a number of chronological windows in which physical capabilities are sensitive to development.

Changes in Physical Characteristics Before and During Puberty (Schramm)

Boys*	8	9	10	11	12	13	14	15	16	17	18
Coordination/agility											
Rapidness/motor reaction											
Extensive aerobic endurance											
General strength endurance											
Speed of locomotions											
Rapid strength [small resistance]											
Intensive aerobic endurance											
Special strength endurance											
Maximal Strength											

Girls*	8	9	10	11	12	13	14	15	16	17	18
Coordination/agility											
Rapidness/motor reaction											
Extensive aerobic endurance											
General strength endurance											
Speed of locomotions											
Rapid strength [small resistance]											
Intensive aerobic endurance											
Special strength endurance											
Maximal Strength											

*The physical abilities in the left column have been re-ordered to emphasize the pattern of optimally sensitive times (orange) and sensitive times (dark grey).

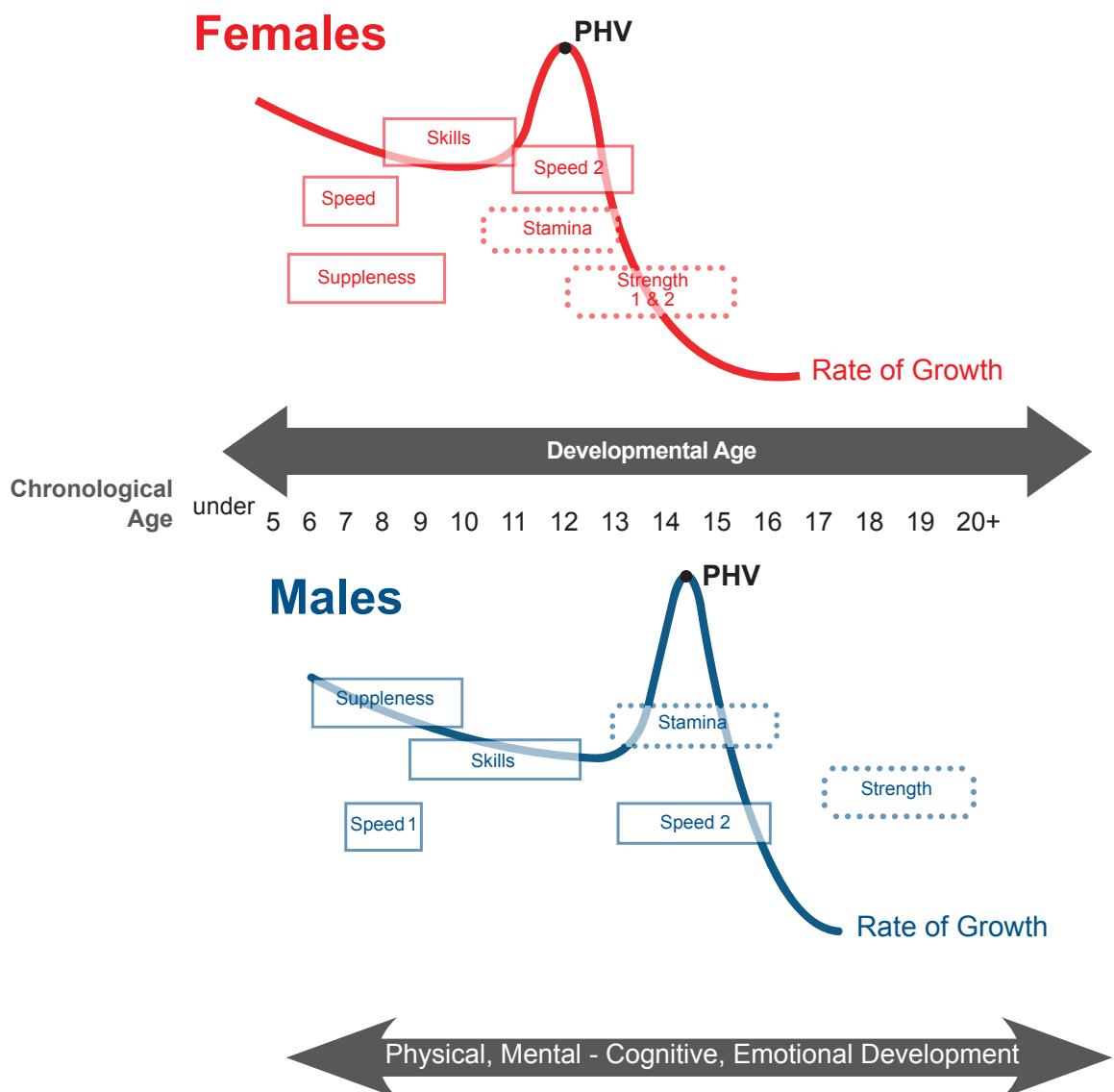
Of particular note here are the strong similarities between boys and girls for capabilities that can be optimized before puberty (8 – 9, above). These are the capabilities primarily learned kinesthetically which are required for learning sport techniques. Capabilities that optimize during puberty show the same male-female time shift, as illustrated in the graphs below.

Of particular note for Biathlon is the “Extensive aerobic endurance” entry. There is general agreement in the literature that children, especially in Mid to Late Childhood are primarily aerobic engines. Children can undertake extensive aerobic exercise provided that the energy demand is not above 80% max. and provided that motivation suitable for their level of mental development is provided. This carries over into early puberty.

Here are the same points, illustrated in terms of “windows of training opportunity” relative to PHV. The message is the same.

- The opportunities to optimize fundamental athletic capabilities occur before puberty.
- Fundamental sport skills should be trained before puberty to take advantage of this sequential expression of genetic potential.
- The opportunities to maximize performance characteristics occur post PHV and after puberty.

Pacific Sport - Optimal Windows of Trainability (Balyi and Way, 2005)



This table of endurance related capabilities was compiled by Andrei Vorontsov (British Swimming) from research done by Vorontsov, Solomatin and Sidorov in 1986 and 1988, presented to the BC Swimming Coaches Conference, October 2002 in Vancouver.

The capabilities selected here are biased towards those more strongly influenced by pubertal development.

Changes in Physical Endurance Characteristics Before and During Puberty (Vorontsov)											
Boys*	8	9	10	11	12	13	14	15	16	17	18
Coordination/Agility											
Flexibility/Mobility											
Aerobic Capacity											
General Strength Endurance											
Aerobic Power											
Special Strength Endurance											
Pulling Force											
Anaerobic Abilities											
Speed/Strength											
Maximal Strength											

Girls*	8	9	10	11	12	13	14	15	16	17	18
Coordination/Agility											
Flexibility/Mobility											
Aerobic Capacity											
General Strength Endurance											
Aerobic Power											
Special Strength Endurance											
Pulling Force											
Anaerobic Abilities											
Speed/Strength											
Maximal Strength											

*The physical abilities in the left column have been re-ordered to emphasize the pattern of sensitive times (dark grey) and optimally sensitive times (orange).

The patterns are very similar to those derived from Schram et al. Although the gender chronology is different, when the patterns are frame shifted to align the onset of puberty, the similarities between males and females is obvious.

Male children are statistically bigger than female children. This statistical difference becomes less pronounced and may be reversed in Late Childhood as some girls begin to enter puberty earlier than boys. At this point, the performance capabilities of the two populations, already close, becomes more overlapped. As the males enter puberty, the performance gaps widen again, especially in strength and power based activities.

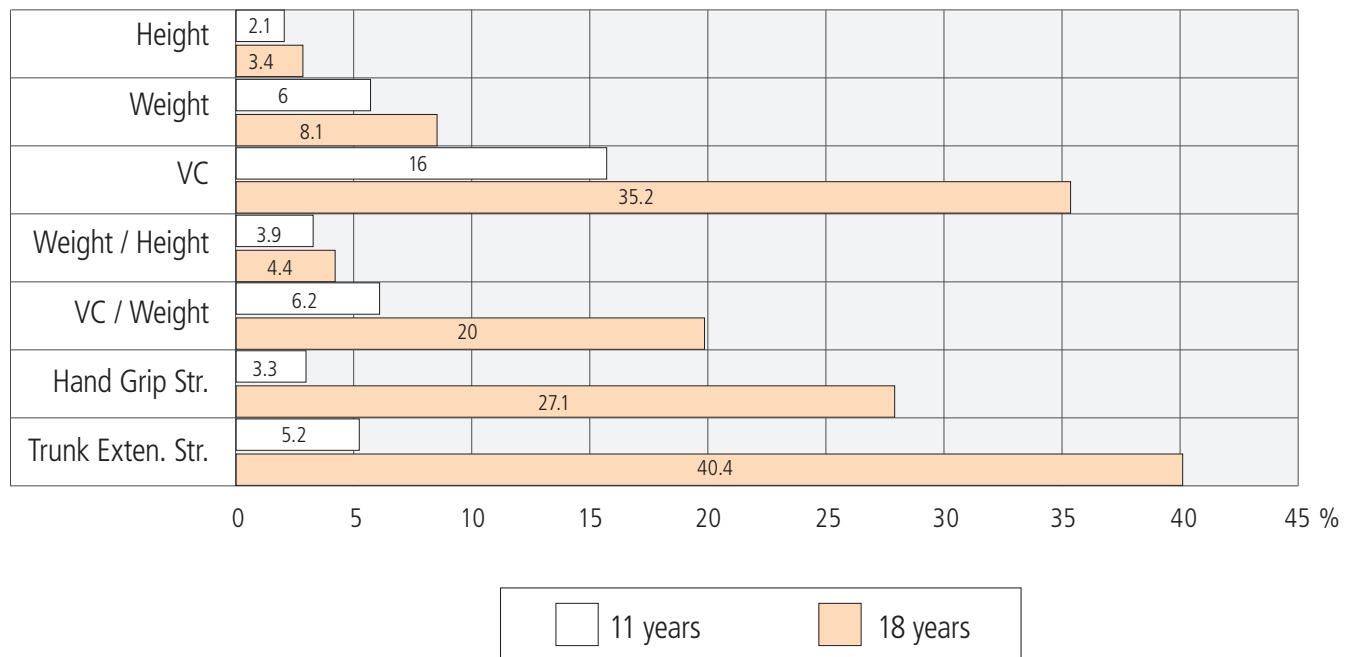
- Males and females go through significant physiological changes once puberty sets in.
- Some windows of optimal opportunity for physiological change close and others open.
- The pattern of these changes is strikingly similar for both genders, although chronologically asynchronous, as it is for individuals.
- The opportunity to perfect performance related capabilities (vs. skills), occurs during and mostly after puberty.
- The timing and duration of the windows of opportunity are dependent on both PHV and transit time.

Training Effects During Development

The next figure is also taken from a presentation given by Andrei Vorontsov (British Swimming) to the BC Swimming Coaches Conference, October 2002 in Vancouver.

The original paper by Vlastovsky compares the physical characteristics of [selected] swimmers with those of the general population. At age eleven (white) there are relatively small but significant differences between the athletes in the swim program and the general population of eleven year olds. This is not so surprising. The difference is most pronounced in VC (aerobic capacity), which is trainable in late childhood (see above). Seven years of systematic training, and passing through puberty, effect large changes in the trainable parameters like VC (aerobic capacity), hand grip and trunk extension strength. For more genetically determined capabilities, like weight and height, the change relative to the general population is slight, and not influenced by training.

**Surpass (in percent) of boy-swimmer over their peers. School-boys non-athletes at ages 11 and 18.
(School-boys - data of V.G. Vlastovsky, 1976)**



Longitudinal studies like this are the basis for the general conclusion that training is more effective if applied over a time period that coincides with a window of developmental opportunity. Here, for example, we clearly see the effect of aerobic training on aerobic capacity during the second, pubertal-window for aerobic development.

- When training modes are matched to developmental opportunities, athletic development is optimised.
- Only trainable capabilities can be optimized in this way.

Part 2: Growth, Development and Sport

Recreational Sport vs. Elite Performance

Mission Statements

Biathlon Canada will achieve consistent international podium performance by leading, promoting, developing and governing biathlon in Canada to the highest standard of excellence.

The purpose and focus of all our programs, services and action is directed at the holistic development and support of the athletes and their performance.

There is an inherent conflict in these statements, as there is in most Olympic sports, engendered by the broad spectrum of participating athletes. The focused drive for world class, elite performance clashes with the holistic development of athletes, most of who will never approach such heights. An LTAD, which starts with very young athletes, aged 6-8, must provide for the many who aspire, as well as for the few who succeed.

Biathlon is inherently competitive. One can cross country ski for recreation, fitness or for competition. One can shoot for recreation or competition. Combining the two, shooting while skiing hard, is at the extreme end of recreation and requires significant infrastructure. It is a challenge, a competition – either to oneself or to other participants.

- Only a small minority of the athletes affected by the Biathlon Canada LTAD are mature, elite performers.
- Competition is necessarily at the core of the Biathlon LTAD

Competition as Play

We are all familiar with the TV footage of bear cubs, lion clubs, wolf cubs – any warm and fuzzy mammal cubs – at play. We see the same behaviour in our children when we get together with the neighbours for a pot luck supper and send an ad-hoc bunch of kids down to the rec. room to play (without a TV). Or when we shoo the kids out of the lodge and into the snow to get them from under foot. The play is nearly always based on competition, with a small “c”.



Running, hiding, skiing, jumping, crashing, chasing, throwing – traditional kids games are based on playful competition - “watch me, I can do this great”. Adult games, now called “sport” try to preserve this same playful innocence with “fair play” ethics, rules to define the playing envelope and, everywhere except Ultimate Frisbee, referees to stop the competition getting out of hand and becoming too adult.

We should keep this clearly in mind. Most people do not play sports to be the best in the world, or even to win, they play sport for self fulfillment, to socialize, to beat their best friend, even if they come last and second last, etc. If Biathlon is to be a sport for more than a very few would-be elite athletes, it has to preserve this element of playful competition. The setting and reward system must be designed to provide an optimal challenge while maximising opportunities for success.

- Sport is playful competition. Programs based on this LTAD should preserve this principle into adulthood.
- The reward system is crucial to inducing the atmosphere and behaviour that supports this sense of play in sport.

Appropriate Competition Styles for Developmental Stages

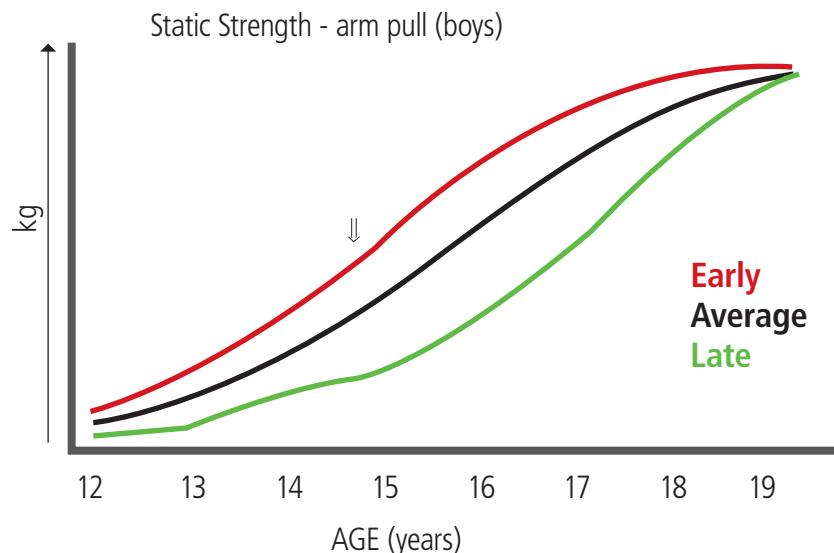
Unlike adults, children are less likely to measure success in terms of winning, but more in terms of effort expended. As they enter puberty, this attitude shifts and is replaced by more adult attitudes, with performance judged by reference to peer group performance and peer-group expectations. Such normative judgements often translate into a measure of self worth. For children, informal competition and play are interchangeable. This is not true for young adults and adults, who see competition as measuring their competence and ultimately, their self worth. For teenagers, with little life experience and burgeoning physical abilities, this competence/self-worth judgement focuses on athletic prowess.

Competitions are more engaging and more fun when the players are evenly matched – no one enjoys participating in a rout. For children, ages 5 through 11, the performance parameters change slowly enough that children who are two to three years apart in age will be able to successfully engage in competitive play, whether these are group or individual activities. Some children will generally be more successful, by adult measures, but if the children are engaged, they will be happy to participate.

- Children’s sport competition must be play-like, engaging, fun, participatory and group or team oriented.

For children entering puberty, physical gains due to hormonal development widen the performance spectrum to the point where age group categories no longer produce engaging, play-full competitions. Imagine the natural performance ability differences for children aged 14-15 as represented by the arrow in the next figure, adapted from Malina and Bouchard, 1991, p. 296.

Early, Average, Late Maturation (Malina & Bouchard, 1991)



This obvious, visible disparity in physical abilities coincides with a growing belief that athletic performance is a measure of self worth. Most people will avoid situations where their self worth is denigrated. Teenagers leave competitive sports based on age categories and selection by performance in droves.

Surveys report that early-pubertal teenagers leave sport primarily because it is "not fun anymore" and because "I'm not getting better". Late-blooming males drop out or are pushed out of sports where speed, power and strength are important because their early blooming competitors get their pubertal boost earlier. We see early blooming females drop out of sports where adult female characteristics are a disadvantage. In short, the various sport systems, focused on finding and improving top-end performances, are not providing a competition environment that allows the majority of pubertal athletes to play by competing, or to validate their self worth by competing against their physiological peer group. Their current athletic peer group is the group of athletes that are at the same stage of hormonal development, not those who are in the same birth cohort.

- Competition for pubertal athletes should be based on competition between athletes with similar, matched, performance characteristics.

The same arguments apply to adult recreational participants. The over-30 adults at Biathlon competitions range from ex-Olympians who are coaching and want to race for fun, to parents who have never done Biathlon before in their lives. Even amongst this latter group, there will be a wide range of fitness and skills. As adults, perhaps their egos do not require as much protection as those of teenagers. However, they would have more fun competing at distances and with competitors that are matched to their capabilities. If they have fun, they will come back.

- Competition for recreational athletes should be based on competition between athletes with similar performance characteristics.

For the elite performers in Biathlon, performance levels at National Championships, World Championships, World Cups and Olympic Games successively set the performance standards. There is no allowance for training, hormonal, or genetic deficiencies. These are competitions between young adults and adults who have gone through puberty and whose performance is based on a stable developmental platform. The competition envelope and the rewards are set by the national and international sport system.

Young adults who are pitted against adult competition before they are ready may suffer the same performance trauma as late-blooming children pitted against early-bloomers of the same age. Athletes who have the potential to become elite performers need to be exposed to a graduated series of competitions that entice them into doing better by allowing them to overcome a series of suitably just-in-reach challenges.

- Appropriate competition structure(s) and the competition reward system are crucial for young adults.
- Elite athletes should compete at the level that is at the edge of their personal performance envelope.

Selection by Predictive Testing

One alternative for selecting elite athletes is to use the physiological and anthropometric characteristics exhibited by great players of the sport to look for prospective elite athletes. The essential process is: 1), identify these elite characteristics, 2), measure a large population to get normative values (e.g. mean performance on test X) and 3), compare individual performances to the norm. Any athletes that are way outside the norm on the plus side will be good at the sport – provided the tests really correlate with sporting success. There are problems with this in Biathlon.

The first, and largest problem is that, in terms of readily available population norms, it is difficult to define a set of success criteria for biathletes. Biathletes seem to come in all shapes and sizes.

In Biathlon, elite men and women come in a large variety of heights and weights; a large variety of personalities; elite women shoot as well as elite men; there is no correlation between ski stride length and height; no correlation between natural visual acuity and shooting skill (because of optical aids); etc. Those characteristics that biathletes do share, could equally well define a cross country skier or a middle to long distance runner.

There is evidence that some genetically determined characteristics, like height and muscle mass, that might be predictive for basketball or weight lifting, correlate well as children age, but these are not the kinds of measures that might be predictive for biathletes. Measures like agility, balance, aerobic endurance, lactate tolerance, focus, and commitment, either do not extrapolate well, are strongly affected by puberty, are not measurable in children or are subject to large training effects or large learning effects, all of which makes predictive correlations difficult for late maturing endurance sports with high skill content. Evidence from longitudinal studies of children indicate that the correlation between performance-test results gets smaller and smaller as the age gap between tests gets longer. This too indicates that predictive testing is unlikely to work for late maturing endurance sports.

- In a late maturing endurance sport, predictive testing of pre-pubertal children holds out small hope for success in talent identification.
- Predictive testing may be useful for talent ID in mid to late pubertal athletes who have acquired appropriate endurance sport skills from other sports.



Marc-André Bédard

Competition as a Talent Identification Tool

Structured competition in individual events virtually always ends up with a ranked list, based on performance. Given a set of rules to define the performance envelope, the competition defines who gave the best performance on the day. Good performers show talent for the sport. If you want to find those that are best at a sport, competition results are an incontrovertible measure of this.

Formal competitions are therefore effective and prime candidates for use as selection tools. In Biathlon, even though we have very objective measures of performance, we allow for human and environmental factors by including multiple competitions on multiple occasions in our selection processes. Given adequate allowance for performance variation due to human and environmental factors, competition is a good measuring stick.

- In late maturing endurance sports like Biathlon, post pubertal selection by competition is most likely to identify the elite.
- In late maturing endurance sports, selection based on competition performance is not appropriate for pre-pubertal and pubertal children.

Selection by Election

The history of minor sports in Canada is full of stories about champion athletes who found their sport by accident. Once introduced to the sport by a friend, neighbour or coach, they liked it and stayed on. Coincidentally, they possessed the characteristics necessary to become champions. Myriam Bédard is a classic example. Some exceptional athletes, like Pierre Harvey or Clara Hughes, were captured by two sports with similar athletic requirements.

Biathlon is a late maturing sport that shares characteristics with a number of other sports. Given the conclusions above about predictive testing and competition, it seems that exposure to the sport, coupled to satisfying sport and competition opportunities, should become a major recruiting tool.

- The LTAD Program should provide opportunities for exposing large numbers of children to Biathlon.
- The LTAD Program should provide for asynchronous recruitment and suitable competition opportunities for cross-over athletes.

Maturation Phases vs. Sport Development Phases

Sport Skills vs. Developmental Stage

The stars in the table below indicate propensity, not performance. More stars indicate that in this phase of development, the human organism has more potential for developing a particular sport characteristic than in a period with fewer stars.

Athletic Ability in this context can be thought of as the ability to perform athletic manoeuvres and actions, not necessarily sport performances. There is a huge potential for developing athletic ability in Mid and Late Childhood, based largely on neurological development and the learning of new neuromuscular movement patterns. For many athletic abilities, these represent learning opportunities that are virtually closed at later ages.

There is a second peak of opportunities centred on puberty, where hormonal changes induce physical and physiological changes that enhance athletic performance. These changes take place in the absence of training. However, exposing athletes to training stimuli that enhance these changes optimizes them.

Both time peaks are opportunities to maximize athletic ability and performance by challenging children with appropriately targeted athletic activities.

Competition Skills in this context means skill in formal, sanctioned competitions, of the kind that define the sport. These may be elite or recreational.

Elite skills are the additional skills required by athletes, which allow them to become the very best in their sport. Elite athletes will show superior performance in commitment, practice and competition. These are skills based on maturity and long-term learning, which are optimized in early-stage adults, before middle age (40-45 yr.). Recreational athletes utilise the same skill sets at lower performance levels.

Sport Development vs. Human Development

	Athletic Ability	Competition Skills	Elite Skills
Early Childhood	****		
Mid and Late Childhood	*****		
Early Puberty	****	**	
Mid Puberty	****	***	
Late Puberty	*****	****	**
Young Adults	***	****	***
Adults	**	****	*****

- Skills and abilities should be taught and trained only at the appropriate times in an individual's sport career.

Biathlon Skills vs. Developmental Stage

In this next section, a number of athletic skills that underlie Biathlon performance are examined for chronological training opportunities. This is not intended to be an exhaustive list, but it clearly illustrates the relevant chronological opportunities and performance abilities associated with childhood development.

The skills in this table are arranged to emphasize the chronological opportunities for training.

This is a 2-D mapping of human development phases vs. Biathlon specific sport requirements. The numbers in the grid represent trainability scores. These are not performance scores, but a measure of how responsive a child, young adult or adult would be to training designed to improve the particular trait in that column.

Developmental Phases vs. Biathlon Specific Development Opportunities												
	Gross Motor Skills	Agility	Balance	Coordination	Memory	Visual Acuity	Fine Motor Skills	Aiming Hitting	Strength 1	Speed 1	Mental Models	Abstract Thinking
Childhood	4	2	2	2	2	2	1	1	1	1		Speed 2
	4	3	3	3	3	3	2	2	2	2	1	2
	3	4	4	4	4	4	3	3	3	3	3	3
Puberty	3	3	3	3	3		4	4	4	4	4	
	2	2	2	2	2	(-1)*	3	2	3	2	3	2
	2	1	1	1	1		2	1	2	1	2	3M/4F
Adulthood	1	1	1	1	1	1	1	1	1	1	2	4M/3F
	1	1	1	1	1	1	1	1	1	1	1	3

Scores, 1-4 indicate developmental propensity. 1 = Some development of this trait; 4 = Maximum development of this trait.

* Visual Acuity: Natural visual acuity may deteriorate during puberty, and may or may not adjust. It will deteriorate in adulthood.

Abstract thinking: Thinking about processes, objects and events that may or may not have real world representation.

Aerobic endurance: Ability to exercise using aerobic energy systems with exertion levels below the anaerobic threshold.

Aiming/Hitting: Hitting a target with an object. There appears to be a correlation between this and aiming a rifle, but there is no direct research.

Agility: The ability to move quickly in three dimensions while remaining in control of the movement.

Balance: Ability to remain upright while moving. Includes static balance and balancing while moving or gliding.

Coordination: Moving several parts of the body serially or simultaneously to achieve movement.

Fine Motor Skills: Movements controlled by small muscles, e.g hand and finger movements.

Goal setting: The ability to set targets for future behaviour or outcomes.

Gross Motor Skills: Large movements of the limbs and body using multiple joints.

Memory: Ability to retain and recall instructions, information and experiences.

Mental Models: Ability to understand and manipulate mental models of real-world processes.

Speed 1: Speed due to improvements in neuromuscular coordination.

Speed 2: Speed due to improvements in energy supplies, in this case alactic and glycolytic energy systems.

Strength 1: Strength due primarily to improvements in neuromuscular coordination, not growth.

Strength 2: Strength increases due primarily to increases in lean muscle mass - hypertrophy.

Visual Acuity: Ability to discriminate edges and see objects at various distances.

The highlighting in this table indicates groupings of skills that mature at and are trainable in similar chronological periods.

The first and second groups of skills in the table include all the elements needed to participate in a shooting program, as well as those skills needed to run, bike or ski as a physical component of biathlon. The best training opportunities for these capabilities come in Mid Childhood through early puberty (pre-PHV), approximately ages 7 – 12/13. Note that this first period includes aerobic endurance, but does not include the anaerobic systems that provide the energy for adult-scale speed and power.

- The best opportunities for training the athletic skills underlying shooting and skiing occur before puberty.

Children in this pre- PHV age group, subject to legal constraints, will be capable of participating in a sport program with elements of Biathlon included. This would be particularly true of programs based on child-sized air rifles.

There is a second window for developing aerobic capacity, during the pubertal growth spurt, when heart, lungs and circulatory systems are growing to adult size.

- Physical skills for shooting and skiing should be trained by late childhood, before puberty.

The physical capabilities required for serious competition, such as anaerobic energy systems (Speed 2) or powerful muscles (Strength 2) are best trained in Mid Puberty or Young Adult phases when the appropriate hormonal environment is present. Note the significant differences here for males and females (See Vorontsev in Part 1).

- Physical capabilities necessary for elite competition train best in late puberty or early adult hood
- Mental skills that support elite competition, such as goal setting, commitment, patience, etc. only mature gradually during the transition into adulthood.



Physiological Abilities vs. Development Chronology

The numbers in the grid represent trainability scores, not performance scores. The numbers indicate how responsive a child, young adult or adult would be to training designed to improve the particular ability.

The highlighted areas represent the optimum developmental stage in which to train these particular abilities. There are some minor differences between males and females in late puberty and early adulthood, in the late developing abilities. Studies indicate that the optimum training windows close down more quickly in females than in males.

Chronologically, females tend to enter puberty before males. If this chart was re-drawn with chronological divisions, for example, 8-9, 10-11, 12-13, etc. the windows for capabilities affected by puberty would be offset to the left by one year for females as compared to males. This is a statistical, population measure. Individual males and females will go through puberty asynchronously. In mixed gender teams, training must be optimized on an individual basis, not on a gender basis.

Physiological Abilities	Childhood		Puberty			Adult	
	Mid	Late	Early	Mid	Late	Young Adult	Adult
ABCs	4	3	2	2	2	2	1
RJTS	4	3	2	2	2	2	1
KGBS	3	4	2	2	2	2	1
CPKS	3	4	2	2	2	2	1
Speed of movement	3	4	2	3	4	3	1
Flexibility	3	4	2	3	2	1	1
Strength, neuromuscular	3	4	4	2	2	1	1
Reaction time	2	3	3	2	1	1	1
Aerobic energy system	2	3	3	4	4	3	2
Anticipation	1	2	2	3	4	4	2
Aerobic endurance	2	2	1	2	3	4	3
Alactic energy system	1	1	1	2	4	3	2
Glycolytic energy system	1	1	1	2	4	3	2
Strength, hypertrophy				2	4	3	2
Strength, power				2	4	3	2

Scores, 1-4 represent responsiveness to training. 1 = Minor response to training; 4 = Optimum response to training

ABCs: Agility, Balance, Coordination and Speed **RJT:** Run, Jump, Throw **KGBS:** Kinesthesia, Glide, Buoyancy, Striking with implement **CPKS:** Catching, Passing, Kicking, Striking with hand

- All of the childhood skills are required as a foundation for serious Biathlon training and competition.
- Training type and training load should be aligned with the windows of opportunity to maximize development.

Part 3: Biathlon Skills and Developmental Chronology

Shooting Skills vs. Development Stage

The scores in the following tables represent performance expectations for the sport and are referenced to the underlying physical and neurological development of children. The highlighted blocks indicate the developmental periods over which one should expect these skills to mature.

Training should commence in the stage indicated by "1". Athletes should be ready to embark on the refinement that leads to the expert stage by the time indicated by "4". True expertise will only develop after stage 4.

Many of the skills needed for biathlon are available, and occur in recognizable form, at an early age. However, either due to the immaturity of the underlying processes, dependence on a related skill or dependence on learning, many of these skills are not fully developed until young adult or adult stages of development.



- The basic shooting skills needed to compete in Biathlon are clearly available by Late Childhood.
- Basic shooting skills needed for biathlon should be trained before Early Puberty.
- Children have the basic shooting skills needed to participate in summer or winter biathlon.
- Shooting training should be timed to the windows indicated by the range 1-4 in the table.
- Firearm regulations and safety concerns with firearms are a barrier to training large numbers of children in biathlon.

Shooting Skills vs. Development Stage

Shooting Skill	Childhood		Puberty		Adult		
	Mid	Late	Early	Mid	Late	Young Adult	Adult
Understands sight picture	2	4					
Aiming precision, rest	2	3	4				
Prone position with rest	2	3	4				
Aiming process	2	3	4				
Natural alignment, prone	1	3	4				
Rifle fit	1	3	4				
Trigger control	1	2	3	4			
Make sight corrections	1	2	3	4			
Range procedure, non-carry	1	2	3	4			
Shooting rhythm, prone	1	2	2	3	4		
Breath control	1	2	2	3	4		
Setup time, prone	1	1	2	3	4		
Prone position		1	2	3	4		
Range procedure, carry			1	2	4		
Self zero			1	2	4		
Aiming precision, prone		1	2	3	4		
Follow through		1	2	3	4		
Standing position			1	2	4		
Natural alignment, standing			1	2	4		
Five shot sequence, prone		1	2	2	3	4	
Coping strategies, technical		1	2	2	3	4	
Race shooting, prone			1	2	3	4	
Shot analysis		1	2	2	3	3	4
Light adjust			1	2	3	3	4
Wind adjust			1	2	3	3	4
Aiming off, prone				1	2	3	4
Group analysis				1	2	3	4
Aiming position, standing				1	2	3	4
Race shooting, standing				1	2	3	4
Five shot sequence, standing				1	2	3	4
Setup time, standing				1	2	3	4
Shooting rhythm, standing				1	2	3	4
Shooting speed, standing				1	2	3	4

Scores, 1-4 represent performance abilities. The numbers represent the kind of performance one can expect, given the developmental patterns shown above.
 1 = Skill recognizable; 2 = Basic execution and timing correct; 3 = Skill well developed; picks appropriate technique as needed; 4 = Skill execution fluid; produced on demand; ready to be polished to elite standards.

Skiing Skills vs. Developmental Stage

As noted above, a major window for learning coordinated athletic skills is mid to late childhood through early puberty.

Ski Skill		Childhood		Puberty		Adult	
		Mid	Late	Early	Mid	Late	Young Adult
Balance, static, forward hop		3	4				
Balance, gliding, two legs, flat*		3	4				
Star turn		3	4				
Balance, static, backward hop		2	4				
Balance, gliding*, two legs, slope		2	4				
Balance, gliding, tuck		2	4				
Snow plow brake		2	4				
Balance, static, one leg		2	3	4			
Balance, static, side-to-side hop		2	3	4			
Balance, gliding, two legs, turn		2	3	4			
Snow plow turn		2	3	4			
Skid turn		2	3	4			
Balance, gliding, one leg	1	2	3	4			
Balance, gliding, side-to-side hop	1	2	3	4			
Balance, gliding, forward hop	1	2	3	4			
Balance, gliding, one leg, turn	1	2	3	4			
Balance, gliding, 180 rotation	1	2	3	4			
Double pole	1	2	3	4			
Skate turn*	1	2	3	4			
Free (speed) skate*	1	1	2	3	4		
Diagonal skate	1	1	2	3	4		
Hockey Stop*	1	1	2	3	4		
Edged turn	1	2	3	3	4		
Step turn*	2	2	3	3	4		
Diagonal stride	2	2	3	3	4		
One-step double pole		1	2	3	3	4	
One-skate		1	2	3	3	4	
Two-skate		1	2	3	3	4	
Offset-skate		1	2	3	3	4	

Scores, 1-4 represent performance abilities. The numbers represent the kind of performance one can expect, given the developmental patterns shown above.

* Gliding skills are easier to develop on skates on smooth ice than on skis over flat but uneven terrain. 1 = Skill recognizable; 2 = Basic execution and timing correct; 3 = Skill well developed; picks appropriate technique as needed; 4 = Skill execution fluid; produced on demand; ready to be polished to elite standards.

- The basic running, bounding and skiing skills needed for Biathlon should be trained before early puberty.
- Children have the basic skills needed to participate in summer or winter biathlon.

Mental Skills vs. Developmental Stage

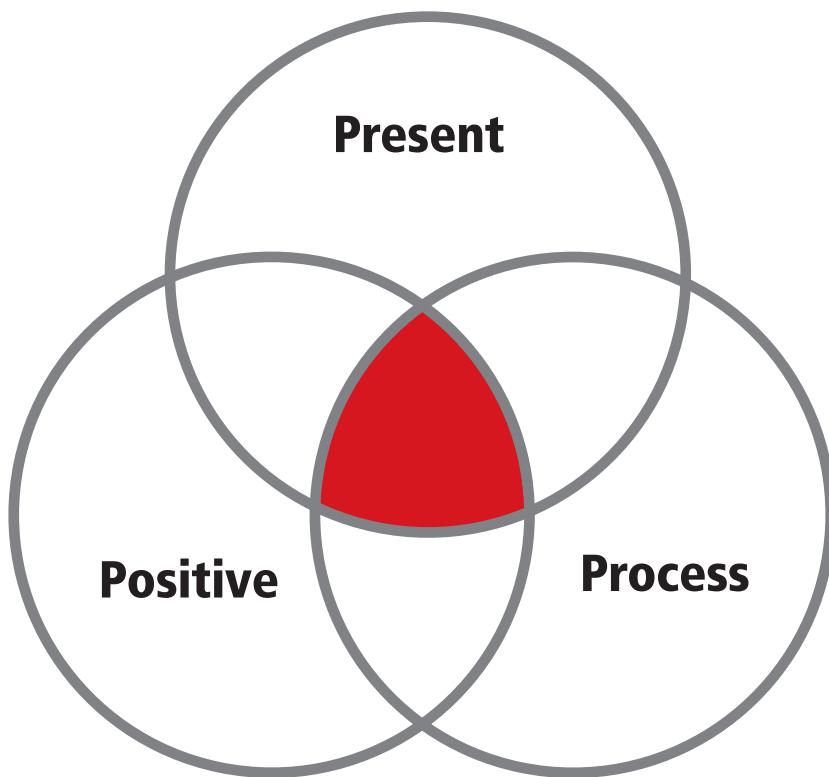
In this section, mental skills are subdivided into various sub-skills in order to illustrate the developmental chronology. The tables represent a broad spectrum of skills that might be subdivided into more or fewer sub-parts. While the end purpose of the skiing and shooting development processes are self-evident, the goal of mental training is to provide the athlete with the tools to master the 3 P's while performing the other two skill sets:

Positive: Maintain a positive, hopeful, or optimistic outlook. Believe in your ability and trust that you have adequately prepared yourself to successfully execute the task.

Present: What must I do at this moment in time to deal with the environmental demands that I currently face? Learn from the past. Plan for the future. Perform now.

Process: Focus on those things that are directly within your control and that are essential to the execution of the skill.

(John Dunn, University of Alberta):



In this section, mental skills are mapped onto developmental chronology. The scores represent performance expectations, and are based on the underlying neurological, developmental chronology. The highlighted blocks indicate the time periods over which one should expect these skills to mature.

Many of the skills are present in recognizable form at an early age and should be trained in a way that matches the child's developmental stage. Either due to developmental sequence, dependence on an earlier skill or dependence on learning, many of these skills are not fully realizable until young adult or adult stages.

The purpose of mental training is to foster a lifestyle attitude that favours the 3 P's, a continual focus on mastery over one's life processes and the events that are within our personal control.

Mental Skills vs. Development Stage

Mental Skill	Childhood		Puberty			Adult	
	Mid	Late	Early	Mid	Late	Young Adult	Adult
Focus control (channels)	1	2	3	4			
Goal setting, for practice	1	2	3	4			
Race Preparation	1	2	3	4			
Relaxation for recovery, guided	1	2	3	4			
Team integration	1	2	3	4			
Task cohesion	1	2	3	4			
Social cohesion	1	2	3	4			
Mastery ethic; process	1	2	3	4			
Time management	1	2	2	3	4		
Accountability	1	1	2	3	4		
Coping strategies, technical	1	1	2	3	4		
Training diary writing			1	3	4		
Goal setting for training cycles			1	2	3	4	
Confidence building	1	2	2	3	3	4	
Attention control (time on task)	1	2	2	3	3	4	
Post practice reflection	1	2	2	3	3	4	
Post race reflection	1	2	2	3	3	4	
Coping, problem focused	1	2	2	3	3	4	
Coping, emotion focused	1	2	2	3	3	4	
Cognitive restructuring	1	2	2	3	3	4	
Communications skills	1	2	2	3	3	4	
Imagery, controlled	1	1	2	2	3	4	
Self talk, control	1	1	2	2	3	4	
Post practice analysis	1	1	2	2	3	4	
Post race analysis	1	1	2	2	3	4	
Coping, avoidance strategies			1	3	3	4	
Race plan, tactics, segments			1	2	3	4	
Motivation	1	1	2	2	3	3	4
Mental simulation	1	1	2	2	3	3	4
Self awareness	1	1	2	2	2	3	4
Arousal control (up and down)	1	1	2	2	2	3	4
Ideal Performance State (IPS)			1	2	2	3	4
Mastery ethic, life goals			1	2	2	3	4
Patience (delayed gratification)				1	2	3	4
Goal setting, for career				1	2	3	4
Performance on demand				1	2	3	4
Integration of all mental skills				1	2	3	4

Scores, 1-4 represent performance abilities. The numbers represent the level of performance one can expect, given the developmental patterns shown above.
 1 = Skill recognizable; 2 = Basic execution and timing correct; 3 = Skill well developed; picks appropriate technique as needed; 4 = Skill execution fluid; produced on demand; ready to be polished to elite standards.

The basic set of mental skills needed to participate in organized sport are clearly available by Mid Childhood.

Training of most mental skills can begin in a general way with six and seven year olds, although in most cases, this training would be informal and presented with considerably less detail and rigour than in the appropriate 3 - 4 zone.

Some late developing skills are dependent upon skills that can be learned at an earlier age, for example, achieving the Ideal Performance State, which requires a complex of other mental skills as well as considerable personal experience, competition experience and analysis to perfect.

Other late developing skills, e.g. Patience or Commitment, are a function of learning and life experience as well as maturing mental abilities.

- Most mental skills take a long time to mature, although some are available early on.
- Children have the level of mental skills needed to participate in non-competitive summer or winter Biathlon.
- Most mental skills needed for participation in biathlon can be trained before Early Puberty.
- Mental training should be timed to the windows indicated by the range 1-4 in the table.
- Mental skills required for elite performance are largely learned skills, and only available in older athletes.

Mental Training Glossary

Accountability: Willingness to accept personal responsibility for outcomes and actions rather than blaming external causes. Necessary step in discovering that incremental improvement is possible (see Mastery). Willingness to assume ownership of one's own development as a biathlete.

Attention control (time on task): Ability to focus [re-focus] attention (and appropriate mental skills) on tasks despite external and internal distractions.

Arousal control (up and down): The ability to adjust the level of mental and physiological activity to match that appropriate for the circumstances. In particular to optimize one's mental state for competition.

Cognitive restructuring: Ability to rethink a situation or position so that it is viewed in a framework that enables action towards problem resolution and encourages optimism. The classic example is: glass is half full vs. glass is half empty – both views can lead to glass-filling activities, but with different mental attitudes.

Communications skills: Verbal, written and non-verbal (e.g., body language) communication skills. Includes the ability to listen, to understand what others are saying, to say what we mean to others in a way that they can understand what we mean, and to convey particular meaning in a way that is not offensive or deceptive in the way the meaning is communicated.

Confidence building: Self confidence reflects the fundamental belief in one's ability to successfully complete the task at hand. Self confidence is a habit for very successful athletes. It is a learned skill, derived from taking on tasks that are a little more difficult than previous tasks and completing them successfully. Critically dependent upon receipt of accurate feedback that is proportional to success. Both under and over praising undermines development of self confidence.

Coping, avoidance strategies: Pre-emptive or pro-active strategies adopted to forestall or avoid problems that can be anticipated to occur in practice or competition environments. Example: if you know that a specific individual has a tendency to irritate you before the start of competition, have a plan that allows you to avoid this person during your pre-race preparation.

Coping, emotion focused: Ability to control one's emotions with specific strategies in circumstances where an emotional response has been elicited. For example, upon feeling anxious before or during a race, can the athlete decrease or lower this anxious response (e.g., through self-talk, confident thinking, cognitive restructuring, perspective taking, etc.).

Coping, problem focused: Ability to cope with and resolve environmental problems. To apply existing strategies and/or devise new or possibly novel solutions to problems as they occur. For example, does the athlete have the resources to successfully deal with broken equipment during competition?

Coping strategies, technical: Specific, learned and practiced responses to common technical problems, e.g. misfires.

Focus control (channels): Switching from one kind of focus to another as the requirements of the task at hands change, e.g. from skiing to range drill, range drill to shooting actions: External-Broad; External-Narrow; Internal-Broad; Internal-Narrow .

Goal setting, for career: Setting general and specific objectives that constitute a career pathway to guide long term sport planning.

Goal setting, for practice: Setting clear, measurable objectives before a practice for subsequent post-practice evaluation.

Goal setting, for training cycles: Setting longer term, clear, measurable objectives before planning a training cycle, to guide planning and to assist with post-cycle evaluation.

Ideal performance state: A description of the physical, mental, and emotional feelings under which peak performances are most likely to occur for an individual. It is best described as a bandwidth or range of feelings that are associated with the athlete's best performances.

Imagery, controlled: The ability to visualize or imagine particular events or processes on demand. Akin to controlled dreaming. Imagery should include all five senses. It is a vivid form of mental rehearsal. May or may not be competition directed in practice.

Integration of all mental skills: The long term goal of mental training. All of the mental skills needed for the 24hr. athlete are mastered and available on demand.

Mastery ethic, life goals: Application of mastery skills to long-term goals that encompass the whole life process, not just athletic skills.

Mastery ethic, process: Approaching tasks with the attitude of "how do I get better at this" rather than "how can I win" or "how can I look good doing this". Mastery ethic acknowledges the incremental nature of improvement and focuses on doing [process] rather than outcome. Process goals are under the direct control of the athlete.

Mental simulation: Ability to rehearse a technique or competition. Uses all senses, includes imagery, self talk and tactical input from analytical skills. Performance oriented and directed at imagining the perfect performance.

Motivation: The intrinsic reasons for pursuing a sport. The degree of motivation and the reasons or desires underlying the degree of motivation will change with time.

Patience (delayed gratification): The ability to carry out activities for which there is no immediate reward or which take a long time, in the expectation that the reward or end point will arrive at some foreseeable, but distant future point.

Performance on demand: The ability to perform as intended irrespective of the external conditions. Ability to reach into one's athletic "tool box" and pull out the necessary tools and skills to perform under almost any circumstances. Requires an understanding that the ideal performance state, may not be present in times of high stress/pressure.

Post practice analysis: Different from reflection; analysis focuses on measurable goals and outcomes, examining processes to seek avenues for improving practice.

Post race analysis: Different from reflection; analysis focuses on measurable goals and outcomes, examining processes to seek avenues for improving performance in competition. Includes external observations and objective measures from outside the performance.

Post practice reflection: Taking the time after a practice to reflect on the events and processes to put the practice into perspective. What was good, bad, ugly; what can I do to have a better race next time?

Post race reflection: Taking the time after a competition to reflect on the events and processes to put the outcome into perspective in terms of the pre-race goals and longer term athletic and life goals; what can I do to have a better practice next time?

Race plan, tactics and segments: Building a plan for executing the competition so as to achieve the competition goals. Linking technical skills and physiological effort to concrete timelines, the sequence of events during the competition, the competitive environment, competition course terrain, etc. e.g. number of shooting bouts, passing points, danger spots, negative splits on last lap, etc.

Race preparation (plans): Setting clear, measurable objectives before a competition to guide planning and execution as well as for evaluation afterwards. Plan your competition; execute your plan.

Relaxation for recovery, guided: After activities, practice or competitions, guided relaxation session to aid recovery from mental fatigue as well as prepare athlete for next event.

Self awareness: Ability to accurately critique and identify one's own personal strengths and weaknesses (physical, technical, tactical, mental, emotional)



ACBQ

Self talk, control: Everybody has an inner voice. Self talk reflects the internal dialogue that an athlete has with him/herself. We may not be able to control the first thought that enters our head, but we can strive to control the last thought that leaves our head. "Attitude is contagious. Is yours worth catching?" Self talk is an essential element of arousal control, confidence, and coping.

Social cohesion: Ability to integrate and interact with team members in an appropriate manner in practice, competition and non-sport contexts that fosters a sense of camaraderie and friendship among the group.

Task cohesion: Ability to coordinate tasks and task sequences into a cohesive action plan and execute the plan.

Team integration: Skills needed to become part of a team and to help others become part of a team. A critical skill in sports where athletes compete as individuals but train and travel as a team.

Time management: The ability to successfully pre-allocate appropriate amounts of time to tasks and to act in accordance with these plans. Integrally linked to prioritization of goals and successful completion of task requirements.

Training diary writing: Critical skill. Writing a training diary requires recording of daily events. This leads to introspection and records the facts and feelings required for post event analysis. Introspection and analysis can lead to accountability, which then leads to the mastery ethic.

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Appendix 1: Community Sport and Elite Athlete Development

Community sport includes participants of all ages and all abilities.

Community sport includes participants of all ages. At various times, at various ages and for various sports, individuals may be involved simultaneously or serially in several sports as recreational or elite-stream athletes. Most people's sporting lives are not a smooth progression through a hierarchy of stages culminating in an Olympic medal. Most people, children, adolescents and adults, will participate in multiple sport activities; an elite biathlete can be a recreational rock climber and a subsistence bow-hunter; an accountant can be a recreational pistol shooter, a charity-run jogger and a Pee Wee soccer coach.

Individuals will move from place to place over time in the continuum of community sport. An Olympic medalist might migrate from recreational sport, through Train to Train and Train to Compete, to Train to Win, and after retiring, return to community sport for recreation; but hardly anybody will follow this nice, linear model of development. Successful biathletes might detour through university, transfer to cross country skiing, transfer into coaching after Train to "X", transfer in from speed skating or cross country skiing at a late stage or take a year off to start a family before returning to elite competition.

Community sport is where athletes develop their love of sport in general and of our sport in particular.

Community sport is where athletes develop their love of sport in general and of some sports in particular. Community sport is also where children develop the basic athletic skills and abilities that are the foundation for life-long athleticism. Community sport for children provides the foundation for athlete development. Community sport for adolescents and adults provides both the feedstock and the matrix for high performance sport.

FUNDamentals captures the element of play that is intrinsic to the way in which the human body hones and acquires its physical and mental skills.

Captured under the rubrics of Active Start and FUNDamentals in athlete development models, the time between learning to walk and the onset of puberty (approx. 3 – 12 yr.) is absolutely critical to physical development. Human development is programmed to respond to various internal and external stimuli designed to elicit full development of the physical and mental traits that make us human. FUNDamentals captures the element of play that is intrinsic to the way in which the human body hones and acquires its physical and mental skills. Community sport must embody this element of play: sport must be fun to be enjoyable, as well as useful from an athletic perspective.

Developing athletic skills in childhood through community sport is a crucial priority for late specialization sports like Biathlon.

During these early years, the human body is primed to learn how to run, jump, balance, throw, kick and glide. These are optimal years for learning and improving these abilities. If this window of opportunity is missed, children do not develop good skills in these areas and do not develop a good kinaesthetic sense – a sense of where their bodies are in space. Opportunities missed here are difficult to compensate for later, compromising both potential enjoyment from life-long athleticism and elite athletic performance.

A multi-sport foundation in community-based sport is a fundamental requirement for developing elite athletes.

It is part of healthy childhood development to explore different sports. Experience has shown that a focus on FUNDamentals and participation in many sports at early ages is key to elite performance as adults. This is particularly true in late specialization sports like biathlon.

A vigorous base in community sport is a fundamental requirement for developing elite athletes. It provides access to the physical skills necessary for childhood development and the introduction to sport that captures a child's imagination. The contribution to childhood development cannot be over stressed.



Christian Mazzoni

Appendix 2: Summary of Training Recommendations Based on Growth and Development

What to Emphasize or Avoid at Various Ages

These guidelines are applicable to the majority of community-based sports.

Mid-Childhood (3-5)

General remarks

- Cannot see the difference between what is real and what is not
- Lives in an imaginary world
- Constantly imitates
- Highly dependent on parents
- Needs to have a well-established routine in daily activities

Psychosocial

- Highly individualistic, even egocentric
- May be afraid of strangers
- Boys and girls may be involved in the same activities

Learning

- Period of life where significant progress is seen in areas such as ability to learn, intelligence, and language; is capable of understanding concepts such as age, time, space, and morality (good-bad)
- Limited ability to concentrate (very short attention span); difficulty understanding abstract concepts
- Limited ability to reason and solve problems
- Cannot take into account most of the information or stimuli from the environment

Physical

- Growth rate is slightly reduced compared to the first two years of life; body proportions become more balanced; head is fragile
- Resting heart rate and heart rate during exercise higher compared to adults
- Development of the nervous system takes place at a very high rate during this period; growth of the brain is approximately 75% completed at three years of age, and 90% at the age of six
- Hand-eye coordination is improved, as well as speed/rhythm of execution of fundamental movements; increased control of movements, which nonetheless remain somewhat jerky
- Motor performance is highly linked to kinesthetic and touch senses

- At age five, activities such as walking or running are usually well mastered and can be incorporated into games; 35 metres can be run in approximately 10 seconds

Preferences

- Likes activities that stimulate several different senses and the imagination
- Likes simple games with easy-to-understand tasks and rules
- Prefers individual activities, yet will share his or her environment of play with others

To avoid

- Any activity that is structured or requires attention
- Activities that feature repeated impacts or where there is a risk of collision
- Repetitive activities (to prevent boredom and also overuse injuries)
- Exposure to a cold or a hot environment
- Comparisons with other children
- Emphasizing the result or performance

Suggestions

- Activities that feature a variety of motor experiences, and where the emphasis is put on the kinesthetic sense (i.e. knowledge of the body and location of body parts in space)
- Simple explanations and provision of manual assistance to the child during the execution of the movement
- All activities should take the form of games
- The instructions and the teaching must be specific, simple, and aimed at a very clear objective
- Creation of small groups where activities take the form of games, with focus on psychomotor development (balance, coordination, movements in all directions, various forms of movement). Where possible, parents should be involved, thus creating an opportunity to consolidate a close relationship with the child through play
- Children need to be praised and complimented generously and regularly for their efforts

Mid-Childhood (6-7)

General remarks

- At this age the child remains fairly individualistic and self-centred; needs a lot of attention and must be in the company of an adult and/or in a small group
- High dependence on parents
- Acknowledges the coach as the leader
- Needs to have a well-established routine in daily activities
- Has no athletic or competitive background
- Interest for sport activities may begin to grow

Psychosocial

- Rather individualistic; often tries to expand social circle and the number of friends, especially with individuals of the same sex
- Sometimes shy
- Is conscious of own feelings and emotions, and of those of others toward him/her; can play on these feelings to obtain privileges
- Boys and girls can be involved in the same activities

Learning

- Learns best by observing, quickly followed by doing
- Short attention span (a few minutes)
- Ability to reason is limited to what is readily observable
- May be afraid of the unknown
- Is likely to imitate and be highly imaginative; is often curious and wants to know everything

Physical

- Development of the nervous system is almost complete
- Rate of physical growth is constant, yet relatively slow; on average, little difference is observed between boys and girls with regard to height and weight
- Head is still very fragile; bones, tendons, muscles, and ligaments cannot sustain heavy loads
- Always seems to be moving; coordination is not very well developed; endurance is low
- Resting heart rate and heart rate during exercise are higher than for adults; resting heart rate is approximately 100 bpm
- Aerobic metabolism predominates during effort; low anaerobic capacity

- Sweating mechanism of children is not well developed, which reduces their capacity to dissipate heat during exercise; children are at an increased risk of heat injuries; children cool off rapidly, and do not tolerate cold well

Preferences

- Enjoys individual activities, with some interaction with the group (e.g. tag); likes to throw, catch, hit, kick, run, jump, climb, and other activities where the whole body is involved
- Enjoys all types of activities that require imagination or involve imitating an adult
- Games should encourage creativity and have few rules

To avoid

- Activities that require repeated impact or wherein there is a risk of collision
- Repetitive activities and activities that feature too much structure (to prevent boredom and also overuse injuries)
- Exercising in a very cold or hot environment
- Using equipment that is not designed for children (i.e. too big, too heavy)
- Specialization in a sport or in a position
- Repetition of all-out efforts lasting between 20 and 60 seconds; work against a high resistance; prolonged aerobic endurance efforts
- Emphasizing the result or performance
- Negative competitive experiences
- Comparisons with other children
- Lengthy explanations
- Negative criticism

Suggestions

- All activities should take the form of games; conditions in which activities or games take place should be varied to promote the development of a variety of motor patterns and skills
- Rules should be adapted to encourage a high degree of interaction between and involvement of participants, and to increase the probability of success during the activity; modified, scaled-down equipment should be used

Late-Childhood (8-9)

General remarks

- Demonstrations should be highly specific, simple, and aimed at the achievement of a well-defined objective; duration of activities should be relatively short, and exercises should change frequently
- Children need to be praised and complimented generously and regularly for their efforts; feedback should focus on one point only; choose the most important one; children should be encouraged to be proud of their own performance, and to congratulate others for theirs
- Basic motor abilities should be developed through games; techniques should be introduced in ways that stimulate the child's imagination (e.g. refer to a funny situation of the child's life, a cartoon)
- Encourage children to drink water, and in hot conditions, ensure that there are plenty of beverages available

Examples

- Relay or obstacle races
- Somersaults, pirouettes, jumps, runs, lateral movements, rope climbing, rope skipping, use of play structures, sliding, throwing, catching, passing a ball with hands or feet; hitting a ball
- Basic strength exercises using the child's own body weight (push-ups, pull-ups, squats with own body weight)



Psychosocial

- Is still individualistic and self-centred, but shows an increasing interest for the group; wants to be accepted by others, and usually shows a great deal of loyalty toward the team
- Needs praise and positive feedback
- Is conscious of own feelings and emotions, and of those of others toward him/her; can play on these feelings to obtain privileges
- Boys and girls may be involved in the same activities
- Seeks the approval of others; may reject opportunities to interact with individuals of the opposite sex

Learning

- Accepts following instructions to learn faster, and reacts favourably to positive feedback/praise; ability to concentrate and to pay attention is relatively good; can begin to make some generalizations
- The emphasis should be on motor development and the learning of skills in a variety of sports
- It is possible to start teaching the rules of the game and fundamental tactical principles
- Is capable of assessing the angles of moving objects (e.g. balls), yet may still have some difficulty distinguishing between right and left
- Ability to reason and solve problems is limited to what can be observed

Physical

- Physical characteristics are similar to children aged 6-7, but coordination and stamina are better; growth rate is slow, which tends to allow for a greater degree of motor control and autonomy

Late-Childhood (8-9)

Physical (cont)

- The development of the nervous system is almost complete
- Reaction time is slow; shows an increased ability to make coordinated and quick movements
- Large muscle masses (e.g. the legs) show a greater degree of development compared to smaller ones (e.g. arms, hands)
- Very little potential for increased muscle mass (hypertrophy); strength gains result primarily from increased coordination and neural factors
- Resting heart rate and heart rate during exercise are higher than for adults; aerobic metabolism predominates during effort and anaerobic capacity is low
- The sweating mechanism of children is not well developed, which reduces their capacity to dissipate heat during exercise; children are at an increased risk of heat injuries



Preferences

- Enjoys individual or group games, and drills where participants are paired
- Likes activities where the whole body is involved (e.g. jumping, running)
- Likes to assume some responsibility, and to take part in decisions relating to games or activities played
- Prefers activities that will allow him/her to shine and to be successful

To avoid

- Activities that feature repeated impacts or where there is a risk of collision; repetitive activities (for reasons of boredom but also to prevent overuse injuries); activities that are too structured
- Mechanical and/or highly repetitive approach to the teaching of fundamental techniques; use of equipment that is not designed for children
- Repetition of all-out efforts lasting between 20 and 60 seconds; work against a high resistance; prolonged aerobic endurance efforts
- Exposure to a cold or hot environment
- Specialization in a sport or for a position
- Emphasizing winning and creating a pressure to perform
- Comparisons with other children
- Negative competitive experiences
- Lengthy explanations
- Negative criticism

Suggestions

- Establish guidelines for acceptable behaviour, and act in a constant and predictable manner; however, accept each child unconditionally
- Children need to be praised and complimented generously and regularly for their efforts; feedback must focus on one point only; choose the most important one; emphasize the following: development of confidence, self-esteem, peer interaction, cooperation, having fun, putting winning and losing into perspective, and giving a 100% effort
- Demonstrations must be highly specific, simple, and aimed at the achievement of a well-defined objective; duration of activities must be relatively short, and exercises must change frequently
- Focus on activities that are aimed at developing coordination, balance, and proper motor patterns; encourage participation in a variety of sports and activities; encourage the use of both right and left hands and feet whenever possible to enhance motor patterns and improve coordination; good age to use speed games
- Modified, scaled-down equipment should be used; competitive games where ability levels are matched; create opportunities for the child to demonstrate the progress he/she has made in a way that will enhance self-image; participants should have the opportunity to take some responsibility, and to assess the impact of such decisions; rules should be adapted to encourage a high degree of interaction between and involvement of participants, and to increase the probability of success during the activity
- Encourage children to drink water, and ensure that plenty of beverages are available when exercising in the heat

Late-Childhood/Early Puberty (10 - 11)

General remarks

- Develops conscience, morality, and values
- May display a highly competitive attitude (wants to look like a competent performer)
- Marked distinctions between boys and girls begin to be visible, particularly toward the end of this period
- May want to break free from the authority of adults, and may show a defiant attitude
- Athletic background may be highly variable among participants; participation in sport activities is often done on a seasonal basis, in programs that can be relatively short (a few weeks)
- Time devoted to general training and acquisition of a variety of skills and motor patterns should be greater than time spent training for a specific activity, or preparing for, or being engaged in, competition

Psychosocial

- Is usually very interested in group activities, and creates strong links with a few friends
- Wants to enjoy a greater degree of autonomy, and wants to help
- Shows a high degree of loyalty to the group
- Begins to be interested in individuals of the opposite sex, without showing it openly
- Expresses his/her feelings easily (e.g. anger, sadness)
- Boys and girls can be involved together in the same activities

Learning

- Child begins to show some ability to deal with abstract concepts, yet prefers concrete examples
- Emphasis should still be on general motor development and the learning of skills in a variety of sports, however fine motor control improves during this period
- It is possible to start teaching a few specialized techniques, as well as fundamental tactical principles; the rules of the games should be well understood
- Capacity to concentrate increases (can stay focused for approximately 10 minutes at a time)

Physical

- Strength and endurance gains are possible as a result of fitness training, but improvements are also directly related to growth; very little potential for increased muscle mass (hypertrophy). Strength gains result primarily from increased coordination and neural factors

- Flexibility improves but it should also be trained
- Reaction time is relatively slow, however good visual acuity and depth perception allow for better performance in throwing/catching exercises
- Sweating mechanism of children is not well developed, which reduces their capacity to dissipate heat during exercise; children are at an increased risk of heat injuries
- In girls, the second half of this period marks the beginning of a major growth spurt that will last approximately 3.5 years; some girls may have their first menstruation as early as 11 years old
- In some boys, puberty will begin at the end of this period.

Preferences

- Enjoys games that feature some competition, team games, as well as activities that require some form of effort or that represent some sort of a physical challenge

To avoid

- Activities that feature repeated impacts or where there is a risk of collision; repetitive activities (to prevent boredom and also overuse injuries); activities that feature too much structure; exposure to a cold or hot environment
- Use of equipment that is not designed for children; repetition of all-out efforts lasting between 20 and 60 seconds; work against a high resistance; prolonged aerobic endurance efforts
- Specialization in a sport or for a position on the team
- Emphasizing winning and creating a pressure to perform
- Comparisons with other children
- Unpleasant or non-gratifying competitive experiences
- Mechanical and/or highly repetitive approach to the teaching of fundamental techniques

Suggestions

- Participation in several sports/activities should be encouraged
- Rules should be adapted to encourage a high degree of interaction between and involvement of participants, and to increase the probability of success during the activity; modified, scaled-down equipment should be used
- Demonstrations should be highly specific, simple, and aimed at the achievement of a well-defined objective; duration of activities should be relatively short, and exercises should change frequently

Puberty (12 - 15)

Suggestions (cont)

- Time when participants are actively involved in activities during practices should be maximized
- Children need to be praised and complimented generously and regularly for their efforts and accomplishments.
- Feedback should focus on one point only; choose the most important one; emphasize the development of confidence, self-esteem, peer interaction, cooperation, having fun, putting winning and losing into perspective, and giving a 100% effort
- Encourage children to drink water, and ensure plenty of beverages are available when exercising in the heat



General remarks

- Period where major growth spurts occur; in each sex, large differences in physical maturation may be observed in individuals of the same chronological age; in general, girls are more mature than boys
- Acquires moral concepts, values, and attitudes that make it possible to relate meaningfully to society; positive role models are important
- Opinion of friends tends to be more important than that of the coach; participants want to look like, or be perceived as competent performers
- This is a period of major change during which participants are likely to challenge authority, be very critical, question decisions, and ask for justification
- Competition becomes increasingly important to some participants; time devoted to general training should be greater than time spent training specifically for a sport, or time spent competing

Psychosocial

- It is important to separate boys and girls for activities and competition
- Emotional instability may be observed due to the rate at which physiological changes occur
- Shows a greater desire for independence; this can be a time of rejection of parental authority and, in general, a period when there is a high degree of confrontation with adults
- Develops close relations with individuals of both sexes; enjoys being more independent, and having more responsibility; a great deal of interest toward sexuality is observed toward the end of this period
- This period is important for the development of values such as respect for others, fair play, and a work ethic

Learning

- Begins to think like an adult. It is important to take into account the different maturity level between boys and girls; interests and abilities differ between the sexes; challenges are often very appealing
- Needs change on a regular basis; is highly curious; capacity to concentrate increases (can stay focused for 20 minutes or more at a time); increasingly capable of abstract thinking
- This is a good period to consolidate the development of fine motor skills, to teach more complex tactical notions, and to encourage decision-making in specific situations

- Specialization by sport and for a position can begin; however, participation in a variety of sports that have different demands should be encouraged

Physical

Girls: The development of secondary sexual characteristics (pubic hair, breasts) begins around 11-11.5 years of age. On average, the growth spurt begins shortly thereafter. Maximal growth rate (or peak height velocity, PHV) is normally observed between 11.5 and 12.5, and menarche (first menstruations) occurs approximately one year after PHV. During this period, body fat content tends to increase progressively, and typical female body forms (hips) appear due to hormonal effect. As a result of these changes, performance often plateaus or may even decline for a short period of time. In addition, for a period of several months following menarche, girls may have difficulty sustaining heavy training loads. Girls should be counselled that this phenomenon is normal, and that their performance will continue to improve after this temporary phase.

Boys: The development of secondary sexual characteristics (pubic hair, testes, penis size) occurs progressively around age 11. On average, the growth spurt begins at age 13, and PHV is reached at around age 14-15. Significant gains in muscle mass and in strength typically occur one year after PHV (i.e. at around ages 15-16) due to higher levels of testosterone; this age represents a good time to initiate strength training with heavier loads if this athletic ability is important in the sport.

- During the growth spurt, feet and hands tend to grow first, followed by the legs and the arms; long bones are fragile during this time; growth is accompanied by an increase in body weight throughout the period
- As a result of the rapid growth spurts that occur during PHV, body parts can be disproportionate; this can have a direct effect on coordination and the ability to perform certain skills that were well mastered before
- This period is well suited for the development of aerobic fitness, as well as flexibility
- Strength and speed-endurance training should begin toward the end of this period

Preferences

- Enjoys challenges and the opportunity to accomplish individual feats
- Accomplishment of actions that are likely to be looked at or admired by peers/friends

- Activities that contribute to the development of fine skills/dexterity and that do not require too much strength (i.e. racket sports, swimming, golf, skiing), team games, situations where some form of competition exists

To avoid

- Repetition of all-out efforts lasting between 20 and 60 seconds before or during PHV; work against a high resistance; prolonged aerobic endurance efforts that involve impact on the joints (i.e. running on a hard surface such as asphalt); repetitive activities (to prevent boredom and also overuse injuries)
- High mechanical stress (compression forces) on the long bones and the backbone, e.g. lifting heavy weights
- Programs where the number of competitions is greater than the number of practices
- Pressure to perform
- Negative competitive experiences

Suggestions

- Time when participants are actively involved in activities during a practice should be as high as possible
- Acquisition of more complex or sport-specific techniques; explanations can be more elaborate, where appropriate
- Correct execution of movements must be emphasized if strength training is performed
- Appropriate supervision of training activities is important to prevent unnecessary risks that adolescents may take
- Games emphasizing skill and dexterity
- Opportunities to meet or interact with sport role models (athletes or coaches); competitions or tournaments that involve trips; social activities among the team/training group
- When an athlete or participant who has reached puberty experiences pain in the joints (e.g. shoulders, elbows, knees), or if he or she now seems to have difficulty completing workouts that could previously be sustained with no difficulty, training loads (amount-frequency-intensity) may have to be decreased to avoid undue stress on the athlete's body
- Depending on the maturity level, involvement of the adolescent in roles such as officiating, or the leadership of certain activities (e.g. leading a warm-up or cool-down)

Late Puberty (16-17)

General remarks

- At the end of puberty, the individual is no longer a child, but is not completely an adult yet, which can create some identity problems
- Late developers may still be experiencing the effects of puberty
- The participant seeks greater autonomy, and progressively becomes more mature emotionally
- Specialization in a sport or for a position may require year-long preparation; however, training may remain a seasonal process, particularly at the beginning of this period
- Training volume increases progressively from one year to another, and may reach 15 hours or more per week, depending on the sport, at the end of this period
- In participants who are training seriously, the amount of time devoted to general training, specific training, and preparing for competition or competing is approximately the same

Psychosocial

- Sexuality becomes very important and participants seek intimacy with others
- Although a greater degree of independence is sought, friends remain very important
- Wants to be considered an adult
- Often, the coach will be a role model; the participant will frequently reject parental authority
- Participants become increasingly aware of their own values
- Social activities are very important

Learning

- Social awareness increases, and as a result participants develop a broader range of behaviours; participants also develop the ability to think logically
- Period when participants begin to specialize in particular sports, and develop broader strategic and tactical awareness

Physical

- Major physiological systems and functions are established; appropriate time to develop aerobic capacity; significant increase in strength and anaerobic capacity (endurance-speed)
- Training of power and speed can be done
- Increase in muscle mass in boys, due to the increased production of certain hormones, in particular testosterone
- Growth in girls typically ends at 17-18 years, and at 19-20 years in boys

Preferences

- Prefers to play the full game or activity, i.e. without modification of the rules or conditions of play
- Prefers activities that contribute to improving physical appearance or to creating a particular status in the eyes of peers (e.g. sport, art, theatre)
- Group activities become important (e.g. movies, dances, parties, travel)

To avoid

- Development of particular muscle groups while ignoring antagonists (e.g. developing the quadriceps but not the hamstrings)

Suggestions

- Delegate certain tasks, provide opportunities for the participant to solve technical-tactical problems and improve decision-making
- All athletic abilities can be trained and developed, relative to the degree of physical maturity of the individual
- Strength-endurance can be trained with no reservations based on the demands of the sport; if increased muscle mass is an important goal to achieve given the sport, this can be accomplished through strength training programs using moderate loads in sets of 8-12 repetitions; all major muscle groups should be developed to avoid muscle imbalances (note: major increases in muscle mass should not be expected in females)
- Strength training with very heavy weights (1-5 repetition maximum, or RM) can be done by both sexes, but with caution and under the guidance of experienced coaches
- Include sessions dealing with officiating, strategy, and tactics
- Creating an assistant coaching role for some appropriately qualified participants may improve self-esteem and peer acceptance
- Important time to work at developing respect for others, and concepts like fair play and work ethic
- Provide opportunities for participants to observe and meet role models

Young Adults (18-20)

General remarks

- Major physiological systems and functions are established, which allows for the training of all athletic abilities
- Self-assured; chooses own path and goes out on his/her own
- Resists involvement in situations which may question self-image as an independent person
- The need to achieve may lead the participant to strive for improved performance
- General training time may be reduced as the serious participant concentrates on specialization and preparation for competition

Psychosocial

- Professional and family obligations lead to much less free time
- Intimate relationships are very important
- Financial independence provides greater opportunity for choice
- May become a member of a group of close friends

Learning

- Adults over 25 years of age often have experience in a broad range of activities (e.g. sport, work, education) which can greatly improve learning and the transfer of knowledge and experience from one area to another

Physical

- Young men stop growing at around 20 years of age
- The individual may expend significant energy and time raising children and working
- Strength, speed, and power are at their peak in the early 20s, and may be maintained through to the early 30s
- Endurance reaches its peak towards the late 20s; after the age of 30, physical capacities begin to decline progressively

Preferences

- Activities that help relieve stress

To avoid

- Nothing; all abilities can be trained

Suggestions

- Interaction with others is important and may take the form of participation in seminars, workshops, or sport training camps
- Individuals may seek roles and responsibilities in the management, organization or promotion of activities and events
- Becoming a coach, official, or referee is one way of keeping this group engaged and committed, and also offers the opportunity for social interaction
- Engage in competitive activities and events in practices



Alan Ball

Appendix 3: The Role and Nature of Competitions in the Developmental Phases of LTAD

Introduction

The focus of this paper will be on the interaction between childhood development and experience in sport competition. The issues of trainability and the sequencing of training for sports are addressed in the main body of the LTAD Model.



Children, Sport and Competition

- Children cite enjoyment as the prime motivator for participating in sports.
- Children have a relatively short attention span and do not react favourably to adult models of athletic training [where the endgoal is clearly separated from the immediate activities]. This begins to change around the onset of puberty.
- Children have an innate need, both psychological and physical, to play games as an integral part of their growth and development.
- It is a common experience that groups of children will play almost endlessly at competitive games, ranging from self-generated, informal games like hide-and-go-seek to more complex self-organized games like shinny or role playing games like cowboys and Indians or latterly, Dungeons and Dragons.
- In the service of recruitment into more formal sports systems, this need to play can be successfully channelled into activities and games with some kind of short term goal or purpose other than athletic development per se. This is commonly done through programs like Community Soccer, Peewee Hockey, Biathlon Bears or Jackrabbit Ski Leagues. Such formal systems are increasingly realizing the value of general athletic skills learned through repetitive play vs. formal drill and instruction.
- At the younger ages, the six to thirteen range, children associate effort more closely with success than with ability to perform.
- Those who try hard are judged successful by younger children. Those with greater ability to perform are judged more successful by older children and young adults. This transition begins with puberty.

- Pre-pubertal children are tolerant of the small discrepancies in performance ability engendered by genetics, and by growth and development from birth through two years. As athletic ability develops through ages two through eleven, these relative differences remain relatively constant.
- Children in the pubertal transition zone, from eleven through sixteen, where most children transform into young adults, become increasingly sensitive to disparities in ability, mostly expressed as differences in appearance and athletic ability. Athletic ability is expressed and measured through informal and formal, organized competition.
- Children between the ages of eight and sixteen attach more importance to athletic ability as a measure of success, which can translate into values of self worth. They see both informal and formal athletic competitions as a valid measure of success and ability.
- Formal and informal competitions are judged successful if the participants enjoy the competition and want to come back for more. See first bullet, above.
- Competitions are more engaging and more fun when they involve participants of similar [performance] capabilities, i.e. similar physiological and technical abilities. A close race or game is always more engaging and more enjoyable than a walkover.
- Competition drives improvement. Competitions are more productive, in terms of athletic development, when they are between participants of similar physiological and technical capabilities. They are also more fun and more productive from a personal development perspective.

Childhood, Ages 2-12 years

The following is true for the majority of children. Although girls tend to be one year ahead of the progression curve for boys, the statistical curves overlap to a significant degree. This period is characterized by a steady rate of physical growth, accompanied by an incremental development of neuro-muscular and mental skills. The salient points are that the whole population develops in parallel, with no sudden changes in ability, and that by the end of this period, ages 10-11, the underlying abilities needed to support technical sports as disparate as Gymnastics and Biathlon, such as eye-hand coordination, limb coordination, memory, mental models, depth perception and visual acuity are developed to near-adult levels. Sport performance still lags a long way behind adults, but the adult forms of the skills are available.

Competition for the whole of this age group can follow the same model. It must be predominantly game-based but can, on occasion, be associated with adult events and trappings, for example, in Biathlon or Cross Country Skiing, short races with bibs and awards, held simultaneously with competitions for older siblings and parents. Awards for this group must be biased towards rewarding effort vs. performance ability.

Chronological groupings of one to two years in span capture groups of children with relatively well balanced athletic abilities. Provided technical training and equipment quality are balanced amongst the participants, the result is the desirable competition experience outlined above. Most adults involved in children's sports as coaches or parents can verify this from personal experience.

Pubertal Transition Zone

This is the chronological period during which a child passes through puberty and becomes a young adult. Unfortunately, the chronological time at which individual children enter puberty is highly varied, ranging from an early point of eleven for girls, through a late point of fifteen for boys. Superimposed on this wide range of initiation points are a variety of transition speeds. Some girls will go through puberty in as little as 1.5 years, others will take 4-5 years. Boys show a similar pattern, ranging from 2 years through 5-6 years.

The transition from child to young adult involves massive changes in the physiological characteristics that affect performance ability – height, strength, speed and aerobic endurance. Everyone is familiar with early teen growth spurts and the disparity in sizes that result in a group of 14 year olds. As a further example, VO₂ max. can increase by over 150% during this transition phase, without special training.

Because the onset and progress of puberty among boys and girls is so extremely varied, some 13 year old competitors are, physiologically, young adults while others are still children. By age fifteen, the majority of competitors will be well into the young adult transformation, but there will still be a significant spread in absolute performance capabilities. Although there will still be pubertal performance gaps at 16, these gaps close to those caused by training and genetic potential as the chronological cohort progresses into young adult hood.

Technical aspects of most sports can be coached with equal facility to children aged 9 to 16, provided the participants have the physical capabilities needed to perform the skill.

Competition During Puberty, Ages 11 – 15:

When participants are grouped on the basis of chronological age, even within the two-year groupings currently favoured by Biathlon, the developmental disparities outlined above lead to competition between individuals with large differences in innate, vs. trained, performance ability .The competition experience, especially in the early years of this phase, is almost the antithesis of the desirable model outlined above. Large disparities in competitive outcome are not rewarding for athletes at either end of the competitive scale, and come at a time when children increasingly associate performance ability with measures of self worth.

If a child's body is not yet ready to make this transition, increased amounts of training will not effect the changes provided automatically by puberty's hormones. A lazy, hormone super-charged early bloomer will beat a keen and industrious late starter nearly every time.

In this environment, the enjoyment and self fulfillment goes out of sport for later bloomers, just before physical and mental abilities gear up to make sports more rewarding. For the early bloomer, who experiences early and easy success, this commonly leads to a "shooting star" effect, characterized by early burn out when their cohort catches up or due to the application of adult training methods while their mental development lags in childhood.

This is a problem that most sports, including Biathlon, must address if we are to have any hope of combating teenage drop out from organized sport.



Alternatives to Chronological Groupings

The purpose of exploring these alternatives is to find a way to maintain the favourable competition environment inherent in the pre-pubertal stages of childhood, despite the disparities of puberty. There is a need to do this to retain more people in Biathlon.

Biological groupings: A possible alternative to chronological age groups is grouping by biological age. Children's growth rates accelerate at the onset of puberty, reaching a peak growth rate, Peak Height Velocity (PHV), near the middle. The PHV can be used to decide which individuals are in what stage of development, and sports medicine tells us which physiological systems optimize during which of the three phases: Pre-PHV, PHV, and Post-PHV.

However, PHV-based pubertal phases are of significantly different lengths for different children. Measurement of PHV involves measurements of a child's sitting and standing heights every month before acceleration starts and weekly until deceleration sets in. Although this is categorized as a non-invasive procedure by sport medicine experts, it is a significant invasion of personal space by North American standards. It is also a significant administrative workload for sports organizations.

To make this concrete, a fast transition child could go through all three phases in 1.5 years, necessitating as many as three category transitions in one December through March competition season. In effect moving from children's competitions to young-adult competitions in one chronological year. A slow transition athlete will gradually progress through three categories in 3-4 years, receiving significantly more training and competition experience before facing up to young adult competition.

Because of the variability in onset and transition speed, together with the necessity of close and exact monitoring and reporting by local officials, competition classes based on the three pubertal transition phases, Pre-PHV, PHV, and Post-PHV, would be very difficult to organize and administer. Significant negative social and psychological outcomes would accrue to early, fast transit athletes as well as late start, slow transit athletes separated from their chronological peer groups by the sport system.

Handicapping Systems: A third possibility for leveling the playing field is a handicap system that in some way compensates athletes for the disparities of development. In some cases, the shooting component of Biathlon can compensate for disparities in physical abilities. However, the underlying skills needed to learn shooting are well developed before puberty, so that if two athletes have equally trained shooting skills, the athlete with superior, puberty-driven strength, speed and aerobic ability will consistently win against his/her more child-like opponent.

Several attempts have been made to devise a points system that will amalgamate and represent the two skills of Biathlon into a single point system that could be used to compare athletes across categories and between competition venues. To date, none has been successfully devised.

If a comparative points system cannot be devised, the prospects for developing a handicap system are bleak.

Result-Based or Self-Selected Categories: This idea came from thinking about house leagues in sports like Squash and Handball, where competitors compete in a league ladder. The ladder allows participants to challenge other players who they know, from the relative ranking, will give them a close game. Close games are challenging to all participants, and seem to be inherently more enjoyable than massacres for all concerned. Fluidity and challenge are maintained through the ladder promotion/demotion rules.

Biathletes in the age range of eleven to fifteen could be given the option of competing in one of three or four categories that are distinguished by increasing performance requirements. This would allow developing athletes to choose to compete against athletes of similar abilities, by choosing which category to compete in. For example, various combinations of prone vs. standing and shorter vs. longer ski distances could be combined to give an increasing range of difficulty. The beginning performance criteria would be similar to the current 13-14 category and those of the upper category would be slightly lower than the current criteria for the first IBU category, Youth Women.

Most league ladder systems have some supplementary rules to keep the system flexible and balanced. A set of Biathlon categories based on the principle of self selection would need some kind of automatic promotion rule, to prevent developing athletes from becoming medal hogs in beginning categories. It would also likely require some kind of demotion rule to protect athletes who are poor judges of their own ability from competing in classes where they are uncompetitive.

The author would like to thank Gerd Erasmus for his input and early critique of this appendix.

Transition Zone Competitions

Transition Zone:

The chronological period during which a child passes through puberty and becomes a young adult.

Competition:

- Children between the ages of 8 and 16 attach great importance to athletic ability as a measure of performance success, which often translates into values of self worth. They see athletic competition as a valid means of measuring success.
- Children cite enjoyment as the prime motivator for participating in sports.
- Competitions are successful if the participants enjoy the competition and want to come back for more.
- Competitions are more engaging and more fun when they involve participants of similar [performance] capabilities, i.e. similar physiological and technical abilities. A close race or game is always more enjoyable than a walkover.
- Competition drives improvement. Competitions are more productive, in terms of athlete development, when they are between participants of similar physiological and technical capabilities.

Background:

- Development of the neuromuscular and mental processes necessary for the technical aspects of Biathlon, such as eye-hand coordination, limb coordination, memory, mental models, depth perception and visual acuity are developed to near-adult levels before the onset of puberty.
- Technical aspects of most sports can be coached with equal facility to children aged 9 to 16, provided the participants have the physical capabilities needed to perform the skill.
- The onset of puberty among boys and girls is extremely asynchronous, to the extent that at 13, some males and females are young adults while others, at 15, are still children.
- This asynchrony in growth and development produces large discrepancies in size, strength and physiological characteristics such as VO₂ max, which results in a wide range of performance abilities within age groups based on this age range.
- These disparities lead to unrewarding competition experiences when participants are grouped on the basis of chronological age. These disparities in competitive outcome are not rewarding for athletes at either end of the competitive scale.

Conclusion:

- A good possibility for satisfying the requirement for enjoyable competition is to set competition classes based on performance ability, as measured by competition results.

