J SPORTS MED PHYS FITNESS 2008;48:65-75

Block periodization *versus* traditional training theory: a review

V. ISSURIN

Elite Sport Department at the Wingate Institute
Netanya, Israel

The basis of contemporary training theory were founded a few decades ago when knowledge was far from complete and workload levels, athletic results and demands were much lower than now. Traditional training periodization, i.e. the division of the seasonal program into smaller periods and training cycles, was proposed at that time and became a universal and monopolistic approach to training planning and analysis. Further sport progress emphasized the limitations and drawbacks of traditional periodization with regard to the preparation of contemporary top-level athletes and their demands. Major contradictions between traditional theory and practice needs appeared as 1) an inability to provide multi peak performances during the season; 2) the drawbacks of long lasting mixed training programs; 3) negative interactions of non-compatible workloads that induced conflicting training responses; and 4) insufficient training stimuli to help highly qualified athletes to progress, as a result of mixed training. The trials and successful experiences of prominent coaches and researchers led to alternative training concepts and, ultimately, to a reformed training approach that was called block periodization (BP). Its general idea suggests the use and sequencing of specialized mesocycle-blocks, where highly concentrated training workloads are focused on a minimal number of motor and technical abilities. Unlike traditional periodization, which usually tries to develop many abilities simultaneously, the block concept suggests consecutive training stimulation of carefully selected fitness components. The rational sequencing of specialized mesocycle-blocks presupposes the exploitation and superimposition of residual training effects, an idea that has recently been conceptualized and studied. It is hypothesized that different types of mesocycle-blocks are suitable to various modes of biological adaptation, i.e. homeostatic regulation or a mechanism of general adaptation.

Key words: Physical education and training - Exercises - Muscle, skeletal, physiology.

Address reprint requests to: V. Issurin, PhD, Elite Sport Department, Wingate Institute, 42902, Netanya, Israel. E-mail: v_issurin@hotmail.com

Training periodization, *i.e.* a division of the entire seasonal program into smaller periods and training units, was proposed and explained about five decades ago.[1-3] This theory began to widespread in Eastern Europe [4-6] and later in Western countries,[7-10] and set up a universal and monopolistic approach to training planning and analysis. The drastic changes and further progress of high-performance sport highlighted inherent contradictions between traditional periodization and the successful experiences of prominent coaches and athletes. Gradually these experiences led to alternative coaching concepts and, ultimately, to a reformed training approach called block periodization (BP). This new approach has been implemented in various sports and has led to outstanding athletic achievements. This progress has been evidenced in many professional reports, anecdotal statements and several publications, mainly journals and coaching magazines.[11-14]. As a result, BPhas become a popular term widely used by coaches and training experts, even if, at the same time, it is difficult to find a systematic and critical description of this concept, which needs thorough professional elucidation. is the aim of this review was then to consider BP of sport training as a general concept and widely used approach to training construction and elucidation.

TABLE I.—*Hierarchy of periodized training cycles (based on Matveyev).*[1, 2]

Preparation component	Duration	Comments
Multi-year preparation	Several years	Two basic modifications: 1) for high-level athletes – Quadrennial Olympic cycle; 2) for other categories – 2-4 year programs
Macrocycle	Several months	Sometimes identified as the annual cycle: includes preparatory, competition and transition periods
Mesocycle	Several weeks	Medium size training cycle consisting of a number of microcycles
Microcycle	Several days	Small size training cycle consisting of a number of days; frequently one week
Workout	Several hours/min	A workout with a break lasting more than 40 min qualifies as two separate workouts

Basics and limitations of traditional periodization

In general, periodization theory exploits the periodic changes in all human biological and social activities. The cornerstones of periodization are made up by a hierarchical system of training units that are periodically repeated (Table I). The upper level of the hierarchy includes multi-year periods like the Olympic Quadrennial cycle; the next level of the hierarchy is represented by the macrocycles, with a duration of one year or of months. The macrocycles are divided into training periods that fulfill a key function in traditional theory as they divide the macrocycle into two major parts: the first for more generalized and preliminary work (preparatory period); the second for more event-specific work and competitions (competition period). In addition, a third and shortest period is set aside for active recovery and rehabilitation. The next two levels of the hierarchy are reserved for the mesocycles (medium-size training cycles) and microcycles (small-size training cycles), whereas the lowest rung belongs to workouts and exercises, which are the building elements of the whole training system. Traditional training periodization, which incorporated the latest know-how of the 1960s, was a breakthrough for coaching and training theory. Many of the elements postulated during these years still remain valid today, including the hierarchical taxonomy and terminology of training cycles, differentiation between general and specific athletic preparation, seasonal trends of exercise volume and intensity, basic approaches to short-term, medium-term and long-term planning, etc.

The bases of contemporary training theory were founded about four decades ago when knowledge was far from complete and workload levels, results and demands were much lower than now. Of course, it would be unrealistic to expect that all the ideas proposed at that time remain applicable today; among the salient limitations of the traditional theory there are: 1) an inability to provide multi peak performances in many competitions; 2) the drawbacks of long lasting mixed training programs; 3) negative interactions of non- (or restrictedly) compatible workloads during traditional mixed (multi-targeted) training; 4) insufficient training stimulus (produced by mixed training) for progress in certain abilities among highly qualified athletes. In this review the Author will consider and discuss these major drawbacks of the traditional theory.

Inability to provide multi peak performances

Even in its later versions, [15-18] traditional periodization presupposed one-, two-, and three-peak annual designs, whereas since the 1980s multi peak performances have become common in high-performance sport practice. This world-wide tendency can be illustrated by the highly typical examples of several outstanding track and field athletes (Table II).

Undoubtedly, such large numbers of extremely successful performances can not be attained following the traditional training design, as they demand a totally different approach to periodization.

Drawbacks of prolonged mixed training programs

The drawbacks of prolonged mixed training programs have been noted for a long time; however, most of scientific evidence of this training insufficiency has been reported during the last two decades. (Table III).

The outcomes of the above research projects highlight typical negative consequences of prolonged mixed training, namely:

1. excessive fatigue accumulation as indicated by persistently increased excretion of stress hormones and creatine phosphokinase (CPK);[24, 30-32]

2. intensive prolonged mixed training yields remark-

TABLE II.—*Multi peak performances in the preparation season of world-star track and field athletes (modified from Suslov).*[19]

Athlete, disciplines	Example	Number of peaks in season	Intervals between the peaks	Total time span for competing
Marion Jones; 100-200 m running, long jump	Season 1998	10*	19-22 days	200 days
Sergei Bubka; pole vault;	Season 1991	7**	23-43 days	265 days
Stefka Kostadinova; high jump	Season 1998	11***	14-25 days	Winter -20 days; spring and summer – 135 days

*Marion Jones (USA); 3-time Olympic Champion 2000; 5-time World Champion. She had eight peaks in running and two peaks in the long jump during her personal season of best results.
**Sergei Bubka (USSR); Olympic Champion 1988; 5-time World Champion; world record holder; all the peaks were within a 3% zone of his season's best result — 595-612 cm.
***Stefka Kostadinova (Bulgaria); Olympic Champion 1996; 2-time World Champion; world record holder; her peaks were within a 3% zone of the season's best result; — 200-205 cm.

TABLE III.—*Impact of long-duration mixed training on sport-specific fitness and adaptation of high-performance athletes.*

Sample	Training description	Evidence
Elite kayakers [20, 21]	12 weeks mixed training with high volumes of strength and aerobic loads	Improvement of muscular and aerobic endurance with stagnation of strength and decline of speed
Elite kayakers [22]	22 weeks mixed intensified training with high specific workloads	Earlier gain of specific fitness and further plateau in late season; high incidence of staleness
Trained junior track and field athletes [23]	6 months mixed multilateral training 5 d/w average 1.5-2 h/day	Improved cardiorespiratory and flexibility variables; no gain of maximal aerobic power, anaerobic fitness and maximal strength
Sub-elite swimmers [24]	12 weeks mixed specific training about 15 km/day	Persistent increase of cortisol, CPK and stress index; no improvement in performances
Elite and sub-elite runners [25]	6 months mixed training with intensity increase from March to August; 15-17 h/w and 6-10 sessions weekly	Anaerobic threshold, $\dot{V}O_2$max and total oxygen debt increased from March to May and decreased from May to August
Trained road cyclists [26]	16 weeks of high-intensity mixed program vs. periodized intensity training	Periodized intensity training improved fitness and performance more than the traditional program
Elite rowers [27]	36 weeks seasonal training including 3 wk intensified prolonged work about 3 h/d	Mesocycle of intensified training lasted 2-3 weeks, approaching critical border of overtraining
Elite junior rowers [28]	6 weeks training prior to world championship changing content and load magnitude	18 days of intensified exhaustive training of 3 h/d causes response near borderline of adaptation
Trained Athletes [29]	6 weeks mixed monotonous and intensified training 6 d/w lasting 40-60 m/d	3 weeks produce enhanced fitness but a further 3 weeks causes deterioration or stagnation

able results initially but stagnation or low improvement rate later on;[20, 22, 29]

3. intensive exhaustive training lasting three-four weeks causes a pronounced stress response when athletes approach the upper limits of their biological adaptation;[27, 28, 30] prolongation of such a program dramatically increases the risk of overtraining.[30, 33]

Interactions of non- (or restrictedly) compatible workloads

Interactions of non- (or restrictedly) compatible workloads is a highly characteristic disadvantage of multi targeted exhaustive training among high-performance athletes. Such mixed training elicits conflicting responses when the loads of certain training modalities suppress or eliminate the effect of workloads directed at other targets. Many studies have shown that prolonged exhaustive mixed training diminishes maximal strength in elite skiers,[34] elite fencers,[35] elite rowers,[36] elite male kayakers,[22] and elite basketball players.[37] Similarly, high-volume mixed training suppresses sprinting abilities in swimmers [38] and elite kayakers.[22] Concomitantly, well controlled studies of elite rowers,[39, 40] elite skiers,[34] and runners [41] indicated that intensive exhaustive mixed training, typical of a precompetition program, reduces maximal aerobic power and/or anaerobic

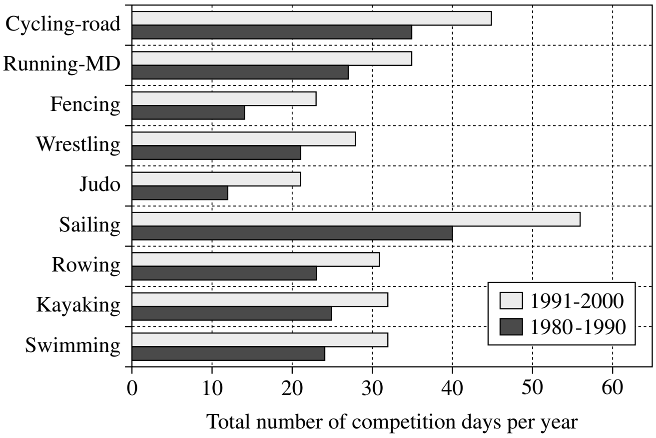

Figure 1.—Total number of competition days in annual preparation of highly qualified athletes in different sports; data obtained from internationally recognized experts in the sports mentioned (modified from Issurin).[79]

threshold. It is obvious that the concurrent administration of training workloads with conflicting physiological responses has a deleterious effect on physiological adaptation, and prolonged use evokes excessive fatigue and staleness.

The mixed training does not provide sufficient stimuli for high-performance athletes

The slogan claims that "*mixed training produces mixed results*".[42] However these mixed results meet expectations of relatively low level athletes, whose multi targeted training still provides sufficient stimuli for progress in various motor manifestations. In high-performance athletes, however, facilitating much more specified responses is of principal importance in order to obtain a high concentration of appropriate workloads that provide a sufficiently large amount of specific training stimuli for their progress.[12, 13, 42] In fact, there is much evidence from elite athletes that multi targeted training does not provide sufficient stimulus for improvement. For instance, highly intensive in-season training of elite road cyclists [43] and elite long-distance runners [44] did not result in an increase of maximal aerobic power, which is decisive for these events.[45, 46] Likewise, highly intensive mixed training of elite speed skaters did not augment their maximal anaerobic power, which strongly affects their performance results.[47] Prominent coaches from different sports have noted the importance of a critical mass of specifically directed drills to obtain planned gains in targeted abilities among high-level athletes.[27,48-50]

TABLE IV.—*The total volumes of yearly workloads (km) in several endurance sports (modified from sources).[12, 53-55]*

Sport	1985-1990	1993-2006
Swimming	1400- 3000	1250-2700
Middle distance running	3300- 5000	3000-4700
Canoe/kayak paddling	4500-6.200	3500-5500
Rowing	5500-6700	5000-6300
Road cycling	35000-45000	25000-35000

Main factors affecting reformation of the traditional theory of periodization

Since the 1980s many postulates of the traditional theory have been discussed following new global tendencies in world sport. The crucial factors affecting the reformation of traditional periodization include:

1. dramatic changes in world sport and training, *i.e.* an increase in the number of competitions and competitive performances and a reduction of the total volume of training workloads;
2. limitations and drawbacks of the traditional model in terms of training design;
3. the introduction of new concepts concerning the design of alternative types of training periodization.

Dramatic increase in the number of competitions

The dramatic increase in the number of competitions has been already noted in the example of world-class athletes (Table II). This global tendency in most sports is the result of international sport federation policy, which has drastically increased the number of competitions involving large numbers of elite and sub-elite athletes.[51-53] Following this tendency, national federations also began to organize many more events than previously. As a result, high-performance athletes participate in many more competitive performances than in the past (Figure 1).

Reduction in the total volume of training workloads

The reduction in the total volume of training workloads became a salient tendency in world sport towards the end of the 1980s. This trend has been marked in different sports and in many countries and can be illustrated as in Table IV.

A similar tendency has been noted in other sports. For instance, world-level hammer, discus and shot-put throwers used to perform 120-150 throws per workout, whereas nowadays such athletes execute only about 30 throws per session (Bondarchuk, 2007; personal communication).

A number of circumstances and factors have probably had a considerable influence on this tendency as a whole a number:

1. some parts of the training routine have been replaced by competitive performances. This factor, which was already mentioned (Table II, Figure 1) strongly reduces training volume. Intense, emotionally charged performances have replaced a substantial part of training routines. Unlike the previous schedule, the contemporary competition season embraces a major part of the annual cycle.[14, 19, 56]

2. Progress in training methods. Social and political changes in recent decades in sport-developed countries have led to extensive sharing of successful experiences among coaches around the world. Coaches' clinics, seminars and courses employ top international experts, who not hesitate to bring up items previously qualified as "top-secret". As a result the level of international cooperation and sharing of advanced training methods has increased drastically.

3. Enhancement of sport technologies. It is obvious that the technological revolution has radically changed training practice. This is particularly true in regard to real-time diagnostics and training monitoring,[57] implementation of new training equipment [58] and materials.[59] As a result the follow up, technologies for monitoring heart rate, blood lactate, movement rate, etc. have been incorporated into practice and have increased the quality of training.

4. Rejection of illegal pharmacological interventions. One of the reasons why training workloads increased so extensively was the administration of certain illegal pharmacological substances, which facilitated physiological responses such as speedy recovery, muscle hypertrophy, etc.,[60, 61] and assisted the execution of extreme workloads. The out-of-competition doping control initiated by the International Olympic Committee in the mid 1990s has made great strides towards preventing the use and proliferation of these harmful technologies in high-performance sport. Consequently, the possibility of performing high-load training programs was also reduced.

New concepts affecting the introduction of alternative training periodization

Already in the 1980s, the term training blocks became popular and was widely used by prominent coaches. As implemented, this term has usually been understood to consist of training cycles of highly concentrated specialized workloads. Without scientific conceptualization, the concept was open to various interpretations. Further consideration of training blocks as a coaching concept leads to the following conclusions:

1. highly concentrated training workloads cannot be managed at the same time for multiple targets and therefore, the number of abilities being developed simultaneously should be radically reduced;

2. athletic performance in any sport usually demands the manifestation of many abilities, which, in the case of highly concentrated training, can be developed only consecutively but not concurrently;

3. unlike the traditional mixed program, consecutive highly concentrated training leads to improvement of targeted abilities while others receive no stimuli and therefore decline, so that the sequencing of appropriate training blocks became extremely important;

4. attaining morphological, organic and biochemical changes requires periods of at least 2-6 weeks, which correspond to the duration of mesocycles; hence, training blocks are mostly mesocycle-blocks.

One of the earliest attempts to build up athletes' preparation based on mesocycle-blocks was executed by Bondarchuk,[13, 62] who created the original periodization chart with three types of properly specialized blocks: 1) developmental, where workloads attain maximal level; 2) competitive, which focuses on competitive performance; and 3) restoration, which is intended to provide active recovery and prepare athletes for the next developmental program. The first two types of mesocycles usually lasted four weeks while the third type encompassed two weeks. The timing and sequencing of these blocks depended on the individual responses of athletes and on the competition schedule. Successful realization of this reformed training system led to amazing achievements: athletes coached by Bondarchuk earned gold, silver, and bronze medals in the hammer throw at the 1988 Olympic Games.

Another well documented attempt to implement an alternative periodization concept was fulfilled in the preparation of elite canoe-kayak paddlers,[11] where the idea of training block- and mesocycle-sequencing was

TABLE V.—*The duration and physiological background of residual training effects (RTE) for different motor abilities (modified from Issurin and Lustig).*[66]

Motor ability	RTE, days	Physiological background
Aerobic endurance	30±5	Increased amount of aerobic enzymes, mitochondria number, muscle capillaries, hemoglobin capacity, glycogen storage, higher rate of fat metabolism [70, 71]
Maximal strength	30±5	Improvement of neural mechanism, muscle hypertrophy due mainly to muscle fiber enlargement [65, 72, 73]
Anaerobic glycolitic endurance	18±4	Increased amount of anaerobic enzymes, buffering capacity and glycogen storage, higher possibility of lactate accumulation [74, 75]
Strength endurance	15±5	Muscle hypertrophy mainly in slow-twitch fibers, improved aerobic/anaerobic enzymes, better local blood circulation and lactic tolerance [68, 76]
Maximal speed (alactic)	5±3	Improved neuromuscular interactions and motor control, increased phosphocreatine storage and alactic power [77, 78]

TABLE VI.—*Taxonomy of mesocycles employed for block periodized planning.*[11, 12, 79]

Type	Training modalities	Duration	Particularities
Accumulation	Basic abilities: general aerobic endurance, muscle strength, basic technique	2-6 weeks	Targeted abilities yield the longest training residuals
Transmutation	Sport-specific abilities: anaerobic (also mixed) and muscle endurance, techno-tactical preparedness	2-4 weeks	Pronounced training responses, accumulated fatigue, shortened training residuals
Realization	Modeling competition performance, maximal speed and quickness, active recovery	8-15 days	Reduced training loads, emotional strain increases pending competition

utilized in a thoroughly prepared training program. Three types of mesocycle-blocks were established: 1) accumulation, which was intended to develop basic abilities such as aerobic endurance, muscle strength, and general technical ability; 2) transformation, which was devoted to enhancing event- specific motor and technical abilities, *e.g.* aerobic-anaerobic and/or anaerobic endurance, muscle endurance, and proper technique; and 3) realization, which focused on precompetitive preparation, *e.g.* race simulation, maximal speed improvement and recovery after preceding exhaustive workloads. These three mesocycle-blocks formed a separate training stage that was completed with several competitions. The annual cycle contained five-six stages, where the last one preceded main season's competition. The modified preparation system allowed reducing excessive training workloads and attained outstanding achievements in the 1988 Seoul Olympic Games.[63]

As already mentioned, the consecutive administration of specialized training blocks is associated with a loss of trainedness in non-targeted abilities. Keeping this in mind, the concept of residual training effects acquires special importance. This concept was first introduced by Brian and James Counsilman.[64] Compared to other types of training effects (acute, immediate, cumulative and delayed), residual effect is still less known and relatively obscure. Based on previous publications [64-66] it can be defined as "*the retention of changes induced by systematic workloads beyond a certain time period after the cessation of training*."

Following the above definition, the duration of the period in which athletes still retain the effect of a previous training block is very important to plan subsequent mesocycles. Studies reveal various factors affecting the duration of training residuals: more prolonged training causes longer residuals,[65, 67] older and more experienced athletes retain their trainedness for longer periods,[66, 67] and abilities associated with pronounced morphological and biochemical changes have longer residuals.[68, 69] Despite the high variability of individual responses, average data pertaining to different motor abilities can be presented (Table V).

It should be emphasized that residual training effect as a phenomenon and concept is particularly mean-

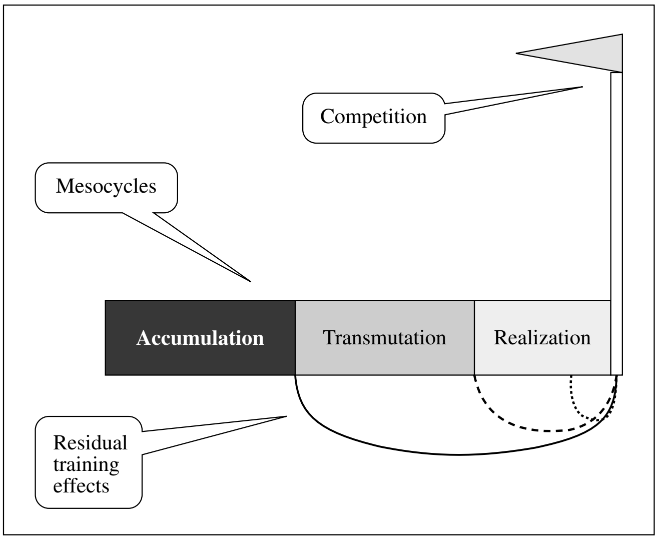

Figure 2.—Superimposition of residual training effects produced by different mesocycle-blocks (modified from Issurin and Shkliar).[12]

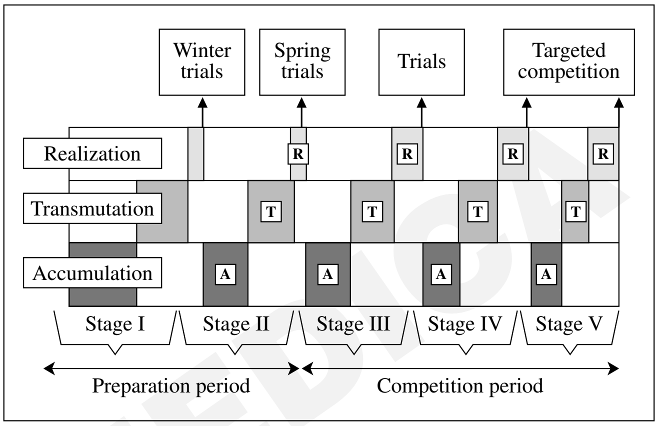

Figure 3.—The chart of annual training cycle compiled following the block periodization approach (the transition period is not shown). Modified from Issurin.[79]

ingful for BP where progress in some abilities and regression in others occur at the same time.

Training compilation in block periodization

The basics of BP [11, 12, 79] suggest three cornerstones of training compilation: general principles, taxonomy of mesocycle-blocks, and general guidelines for training design.

General principles of BP

General principles of BPdetermine the basic approach to training design.[12, 79] The main principle postulates a concentration of training workloads. It presupposes that highly concentrated means only provide sufficient stimuli to enhance targeted abilities in high-performance athletes. Obviously, such high load concentrations within a given training block can be provided for a very limited number of targeted abilities. Thus, the second principle postulates a minimal number of target abilities within a single block. For most sports, the number of decisive abilities exceeds the number of targeted abilities that can be developed simultaneously. Therefore, the third principle calls for the consecutive development of many abilities. Both theory and practice demand that the simultaneous use of compatible workloads will provide a higher and more predictable effect. Consequently the fourth principle declares the compilation and use of specialized mesocycles- blocks so that expected negative load interactions can be excluded.

Taxonomy of mesocycle-blocks

Unlike the traditional theory where eight to ten types of mesocycles were proposed,[2, 4, 16] the proponents of BP offer a very compact mesocycle taxonomy, comprised of three mesocycle-blocks.[11, 13, 80] The taxonomy composed of accumulation, transmutation and realization mesocycles has been adopted in numerous methodic and research projects [65, 81, 82] and has implemented in practice for over two decades (Table VI).

Therefore, the general idea of the BP is embodied first of all in medium sized training cycles, termed mesocycle-blocks, which are much more concentrated, more specialized, and more manageable.

General approach to compilation training

As already stated, the most meaningful component of the revised training approach is the mesocycle-block. The triad of different types of mesocycle-blocks forms the training stage. Their rational sequencing and timing within the training stage makes it possible to obtain optimal superimposition of residual training effects, as displayed in Figure 2.

As shown in the diagram, the accumulation mesocycle has the longest training residuals. The transmutation mesocycle produces shorter residual training

TABLE VII.—*Principal differences of training design based on the traditional approach and BP (modified from Issurin).*[79]

Characteristics of the training design	Traditional model	BP model
The dominant principle of workload compilation	The complex use of different workloads directed at many abilities	The use of highly concentrated workloads directed at a minimum of targeted abilities
Scientific background of the planning approach	Cumulative training effects	Cumulative and residual training effects
Temporal sequencing in developing different targeted abilities	Predominantly simultaneous	Predominantly consecutive
The main meaningful planning component	Period of preparation: preparatory, competitive and transitory	Stage of preparation that includes and combines three types of mesocycle-blocks
Participation in competitions	Predominantly in the competitive period	Predominantly at the end of each stage
General physiological mechanism	Adaptation to concurrent training stimuli affecting many different targets	Superimposition of residual training effects induced by highly concentrated training stimuli

effects, while residuals of the realization block, *i.e.* maximal speed and event-specific readiness, are the shortest. This provides us with the principal options for obtaining optimal interaction of training residuals, so to facilitate competitive performance at a high level for all motor and technical abilities. A simple calculation based on approximate mesocycle duration (Table VI) yields the expected length of a training stage of about two months. In reality training stages can be longer in the preseason, when morphological and organic adaptation requires relatively more time, and shorter in late-season, when the calendar of important competitions dictates more frequent attainment of peak-performance. Finally, the total number of training stages in an annual cycle usually varies from four to seven depending on the features of each sport, the calendar and frequency of important events, etc. (Figure 3).

It is worth noting that BP as a new training concept and methodic approach gives coaches great creative freedom and allows many options for practical application. Since the differences between the traditional model and BP are very meaningful, they can be easily pinpointed (Table VII).

One more important remark can be made regarding the utilization of altitude training. Altitude camps can be effectively inserted in appropriate training stages in order to emphasize adaptation responses and exploit post-altitude effects in subsequent performances.[83, 84] The other benefits of BP pertain to the possibility of reducing total training volumes,[82, 85] providing better training monitoring that focuses on targeted abilities,[11, 82] effectively maintaining mental concentration and motivation level while directing the training routine to a reduced number of targets,[86] providing the desired correspondence between training modalities and integrating rational nutrition.

Conclusions

Summarizing this introduction to BP as an alternative training concept, it is worth considering its essence in the context of the most generalized biological mechanisms of human adaptation. These mechanisms include homeostatic regulation and general adaptation.

Homeostatic regulation refers to the body's attempts to control the constancy of its internal milieu.[87] Such rigid biological constants like body temperature, osmotic pressure, pH, ion content, water-electrolyte balance and oxygen tension (pO_2) tend to be maintained at the same level over the whole life span. This regulation mode corresponds in general to a large group of training modalities, which are intended to enhance the basic metabolic background, oxidative enzyme activity, and the rate of biochemical and hormonal reactions in support of muscular effort and recovery.[88] Thus, homeostatic regulation facilitates the execution of basic workloads for cardiorespiratory fitness, morphological and organic adjustment, and general neuro-muscular coordination. In other words, this type of biological regulation predominates in the early phases of preparation in traditional training periodization and in each mesocycle-block intended to develop basic motor and technical abilities, i.e., the accumulation mesocycle-block. A persistent increase of training demands (intensity, power, velocity regimes) triggers mobilization of the body's energy resources, which surpasses the level that is necessary to maintain homeostatic regulation. At this point the stress adaptation mechanism becomes prevalent,[89] and athletes respond to these loads by mobilizing energy reserves and protein resources, and activating body's defense faculties.[90] These extraordinary actions are associated with a profound endocrine response, *i.e.* the excretion of stress hormones. Thus, intense anaerobic glycolitic exercise elicits rapid catecholamine response,[90, 91] excretion of cortisol,[88, 92] corticotropin and, –endorphin.[92, 93] Such training modalities and exercise induced stress reactions are highly characteristic of mid- and late-season programs in traditional planning and of the transmutation mesocycle-blocks in BP.

Therefore, when athletes execute a training program demanding exclusively or mostly homeostatic responses, they enable the body to enhance the appropriate abilities and even to broaden the limits of homeostasis. Intense exhaustive training programs activate a general adaptation mechanism, which transforms and amplifies metabolic, hormonal and adaptive protein synthesis responses.[88, 93, 94] When exercises of both types are utilized concurrently (mixed training), energy needs definitely surpass the limit of homeostatic regulation and stress reactions become prevalent. Correspondingly, a more strained metabolic and hormonal background aggravates and suppresses homeostatic regulation and disrupts the training effect of exercises for basic athletic abilities. Dramatic consequences of this deterioration can be found especially later in the season of elite and sub-elite athletes, namely: a decline of maximal aerobic power and anaerobic threshold,[25, 34, 40, 41] a decrease of maximal strength,[22, 34-37] performance impairment,[24] and incidences of overtraining.[30-32] In contrast, BP proposes a separation of workloads producing conflicting physiological responses and thus facilitates a situation in which each mesocycle-block employs its proper combination of training loads and exploits the appropriate mode of biological adaptation.

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