



## PERIODIZATION OF A GYMNAST'S CAREER

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A coach's long-term goal is to get the most out of the innate capacity that an athlete has to adapt to training, by the end of the athlete's career. This innate capacity of an athlete to adapt to training is not infinite; for example, elite athletes eventually do not respond well to simply more training. Moreover, this capacity of an athlete to adapt to training is not general: an athlete cannot be a world class sprinter and long-distance runner at the same time, even if both are running (Werchoshanskij & Viru, 1990). Some individuals develop in the direction of, for example, marathon running, while other individuals, gymnastics. Very different innate traits and adaptations to training are involved. Marathon running involves relatively small forces exchanged during repeated, stereotyped movement, for a long time, without resting. Gymnastics involves extremely high forces exchanged while making complex, often very quick movements, in up to six different events, placing great demands on an athlete's ability to coordinate their movements (Arkaev & Suchilin, 2004).

Most coaches are familiar with cycles of training periods according to what needs to be accomplished during the year, for example, general preparation, gymnastics-specific preparation, immediate pre-competition preparation, competition, and transition or restitution. Based on these periods, the gymnast's practices are organized into macro-cycles of practice sessions according to different goals. On the basis of these macro-cycles, meso- and micro-cycles are set up, finally determining the individual practice sessions. At the highest level of performance, training is organized around the four year Olympic quadrennium (Arkaev & Suchilin, 2004). However, we should be skeptical about some periodization research. For example, in much periodization research, the authors did not control for performance enhancing drug use. Even the basic concept of "cycles" in periodization is suspected to have come from a need to alternate periods taking anabolic steroids, which inhibit the body's natural testosterone production, with periods required to re-establish a healthy, legal physiology.

Nevertheless, an athlete cannot always be in a state of peak personal fitness, and cannot always remain in peak fitness, if she or he is to progress. Periods with more fatigue, necessary for improving fitness, but reducing fitness for competition, must alternate with periods of peak readiness to compete. The periods of peak readiness to compete then seem to stabilize the high level of fitness developed during periods with more fatigue. This is the basis of training periodization, whether the training is organized in "cycles" or not (Matveev, 1965). Even if we can't be certain that greater gains are made with a periodized training plan than without, periodization is also a method for systematically avoiding overtraining by including periods of reduced training in the plan.

The basis of any plan of an athlete's training and competing should be the most important process for success in competition. For the marathon runner, this would be aerobic capacity relative to body weight and the supercompensation of muscle glycogen, performance determining factors in this event. In gymnastics, these are the movement coordination abilities. And the coordination abilities do not develop steadily, but instead during critical, or sensitive, periods of time. During such periods, the coordination abilities develop to a higher level, faster, with less training, than at any other time in life. What is more, apparently development that is not achieved during a sensitive period cannot be recovered later. Therefore, these periods are the basis of a gymnast's career periodization plan.

### **Critical and sensitive periods**

Any discussion of planning the career of a gymnast must involve the training of children because there is so much to learn and develop that the gymnastics training process must begin at a very young age in order to have enough time to learn and develop all of the basics that are the foundation of advanced acrobatics skills and combinations. This is not just a question of putting the intensive, gymnastics-specific training during the age when skills are most easily learned (Krüg, 1987). The development of a high-performance gymnast begins in childhood because there is so much to learn. However, children's development is not continuous, but occurs in critical or sensitive periods of development. Therefore, a long-term periodization plan should be based on children's and adolescent's critical or sensitive periods. A **critical period** in human development is a stage in life during which the body's capacities have a greater reaction to certain stimuli than at other times. A critical period of development is a window of opportunity during which the gymnast and coach can get a bigger return for their efforts than at other times. Moreover, if a physiological system is not or little stimulated during this "critical period" some functions may not fully develop. Functions that help an organism survive, such as vision, usually have critical periods. The critical period for the development of a child's vision is believed to be between three and eight months. Similar critical periods have been found in the development of hearing and balance. Learning the first language has been shown to have a critical period. People who learn a language after this critical period rarely speak without accent. Most living things have critical periods in their growth and development, so there should be no surprise that gymnasts also have critical periods during their growth and development.

**Sensitive periods** of development are longer periods during which exceptional development is still possible. What this means is that during these periods, the "trainability" of the gymnast, hers or his adaptation to a certain training, is greater than at other times. The career period plan of the gymnast should be based on exploiting these periods for maximum development. There are certain tasks that need to be accomplished during each respective period. For example during the sensitive period for development of flexibility, the gymnast should acquire all over-splits and L-grip shoulder flexibility, and then this is just maintained during the rest of the gymnast's career.

Critical and sensitive periods of development have been identified by comparing average performance on tests at different ages. However, profound skepticism should be directed at comparing average performance data. Whenever the reader encounters the words "average" or "mean", the reader should remember that the absolute value of the standardized differences often

dwarfs the difference between averages (Raczek, 1987). In other words, the strongest girl is much stronger than the weakest boy at age 16, even though on the average, boys are stronger than girls at age 16. The stiffest girl is less flexible than the most flexible boy, even though the average girl may be more flexible than the average boy at almost all ages. This skepticism is equally valid for comparing “early” and “delayed” developers of the same gender. The “early” developed typically begin puberty during childhood and “delayed” developers begin puberty during adolescence. The strongest late developer can nevertheless be stronger than the weakest early developed child. Individual differences are what coaches have to deal with, not statistical averages. Nevertheless, the concept of sensitive periods of development can be a useful foundation for a long-term periodization plan of the training when the plan is adapted to individual differences.

There is no consistent improvement of movement abilities during growth and development: periods of rapid growth and development precede and follow periods of stabilization with little change, almost regardless of training. The sensitive periods of development of movement abilities, body height, and weight in children and adolescents intensively practicing sports show considerable individual variation. These individual variations depend on the child’s biological age, the sport, the dynamics and specifics of the training and competitions, as well as environmental influences. In comparison, these periods of development of children who are not intensively practicing a sport depend mainly on genetics, even if body height and weight correspond to chronological age in both groups. The sensitive periods of development of the movement abilities of young athletes like gymnasts are different from those of more sedentary children. The development of the movement abilities of child-athletes during a sensitive period is linked with the training and competition exercise as well as genetic processes. Most movement abilities improve during the “growth spurt” phase between ages 12-16 and then these abilities are maintained after the sensitive period.

### **Sensitive periods in the development of the gymnast**

Differences have been measured between biological age and calendar age of up to 3 years in eleven year old girls and boys, and 3.4 years between 13 year old boys (Martin, 1980). Consequently, the following indicated age ranges must be interpreted with up to 3 years, 1.5 years older or younger, additional spread. Body height and weight of girls and boys increases rapidly between ages 11 and 15. The greatest increase in both height and weight occurs during puberty. However, girls tend to develop earlier, and also more rapidly than boys. The greatest growth spurt occurs on average two years earlier in girls than boys. Puberty in girls happens often two years or more earlier than in boys. Girls earlier and more rapid development makes their sensitive periods also more brief. Consequently, the coach’s emphasis needs to be more punctual and concentrated in women’s gymnastics.

Then there follows a period of increased strength development, peaking between ages 16 and 18. Up to and including age 11, strength improves relatively slowly, although children selected for competitive gymnastics commonly already show exceptional strength compared with their peers. I have not found data on the development of relative strength, maximum strength/body weight ratio, very important in gymnastics. Then follows a period of stronger strength development, peaking between age 16 and 18. The most statistically significant increase in strength endurance is observed between 16 and 18 years in girls and 18-20 in boys. The central nervous system develops

earlier than the metabolic processes responsible for power or endurance. The age range 12-18 (males) and 10-12 (females) is the most favorable for developing coordination capacity. This explains the early specialization and success of young athletes in sports like gymnastics, figure skating, or diving. Already by age 7, development can be observed in the various components of movement quickness. The most intensive improvements in reactions to signals with movement happen during ages 14-17. The most significant increase in reaction speed happens between ages 7 and 11. Further improvements in reaction speed continues after age 18 in boys. Reaction times with complex movement sequences improve most between ages 11 and 16. Maximum movement frequency improves most in the 10-13 age range, but improvement continues until age 18.

### **The Periodization Plan**

The development of a high-performance gymnast begins in childhood because there is so much to learn. Moreover, children have proven to be so adept at learning and performing at a high level of gymnastics, that national teams have become younger and younger as more gymnastics specialized training is done at a younger age (Krüg, 1987). It has been necessary to impose lower age limits for participation in international and national competition. However, recent examples of elite gymnasts with long careers into their twenties, even after motherhood, supports the idea that the age of peak performance is older than previously thought. This, in turn, would give gymnasts more time to develop, particularly female gymnasts.

The sensitive period for the development of the coordination abilities is at the end of childhood, the prepuberal phase of growth and development. According to Hirtz (1979), the quality of the coordination ability is the foundation for further movement and athletic performance development, not only in gymnastics. The development and quality of the coordination abilities influence the speed and quality of the learning processes of skills and techniques. These abilities make possible rapid adaptation to changing competition conditions, changes in the Code of Points, and thereby stability and consistency of performance in a multitude of situations, as well as rapid and efficient learning.

Research suggests that the “movement coordination abilities” are actually three different abilities that develop independently, and therefore must be trained and developed specifically (Zaciorskij, 1972). These are

- **movement learning ability:** the ability to learn new skills, techniques, and variations quickly, with a minimum of attempts, and retain the learned skill with a minimum of practice;
- **movement variation ability:** the ability to change or adapt already learned skills and techniques to new situations, connections, or uses;
- **movement performance ability:** the ability to reproduce an already learned skill, regardless of external or internal disturbance, with efficiency, and economy of effort.

The age range up to 12-18 (males) and 10-12 (females), is the most favorable for developing the coordination abilities. However, if the technical practice consists of drilling a narrow variety of exercises and compulsory routines, all the coordination abilities will not be challenged and fully develop; only the movement performance ability, but not the learning and variation abilities. For

movement learning ability or movement variation ability to develop, the gymnast must attempt assignments that are new, different, unusual, and varied, as well as challenging.

Several authors suggest that the big increase in the acrobatic difficulty and complexity in sports like gymnastics, diving, or figure skating over the past five Olympic quadreniums has been due to a solid mastery of the basic techniques at a young age, the key movements of future highest difficulty skills (Knoll, 2006; Knoll et al., 2010). Arkaev and Suchilin (2004) have advocated that these basics in gymnastics should be taught as if they were to be performed by an elite. Many highly successful gymnastics coaches have emphasized that it is important to begin to learn and practice, but not necessarily compete, the highest level skills at a very young age (Krüg, 1987). All this is based on highly developed coordination abilities as well as, in turn, further developing these coordination abilities.

For these reasons, I propose a periodization of the entire career of the gymnast. In the sequence micro-cycles and meso-cycles, these would be mega-cycles. Gymnastic coaches have recognized since the early 1980s that training must begin with the very young, who often have the same coaches for most of their career. There is much research that suggests that a periodization based on critical or sensitive periods during development would be a way to improve the training of a gymnast and come closer to fully exhausting the gymnast's innate capacity to adapt to training. What follows is a suggestion to periodize the "what should be done" over time instead of most periodization plans that address the "how many" repetitions and exercises "when".

### **Periodization model of the career of the gymnast**

A career periodization plan for gymnasts should meet three criteria. First, the periodization models must be based on the sensitive phases of development of

- Coordination (learning, variation, performance ability)
- Joint mobility (static and dynamic)
- Strength and power

Second, two models are necessary (Fig. 1. and 2.), male and female, given the important differences in time course of the critical and sensitive periods of development of males and females. For the purposes of Fig. 1. and 2., I have chosen age 5 as the beginning because in most societies, this age is considered to be the age when the child is mature enough to take instruction. However, if the gymnast has started the Foundation Period at an older age than the sensitive phase of development, then this opportunity for accelerated and amplified development can no longer be exploited. If the first, Foundational Period is started at an older age, the sequence of periods and their goals remain the same, simply more compressed in time because the age of peak performance remains the same.

Third, please notice that the training goals of each Period could systematically prevent specialization at too young a level of development, as well as preventing overtraining like other periodization models. The five Periods of a career periodization are a systematic variation of goals, means, and methods to build the best possible gymnast. Just like an annual plan that is divided into Preparation Period(s), Competition Period(s), and Transition Period, the

career plan is divided into five periods: Foundation Training Period, Developmental Training Period, Training for Performance Period, Peak Performance Period, and Transition Period. Each period has different goals:

Foundation Training Period: the main training goal is development of athleticism with an all-around, basic training

- Playful and varied movement education, collecting movement experiences in many, and different kinds of athletic activities, in a systematic way
- Learning to swim, run, jump, and throw
- Learning the basic forms of the fundamental techniques and skills of gymnastics
- Learning to remember and complete assignments, corrections, practicing independently, as well as in a team

Developmental Training Period: main training goal is the beginning of a specialization in gymnastics

- Learning the skills and techniques of gymnastics
- Expanding movement learning with related sports and multi-sport education, for example dance, trampoline, diving, obstacle courses
- Use of specific exercises to develop the abilities (strength, power, flexibility, coordination) that are the foundations of the basic gymnastics skills
- Begin exercises to prevent common gymnastics injuries, for example ankle sprains in female and shoulder tears in male gymnasts
- Beginning to compete

Training for Performance Period: the main training goal is specific training to improve performance in gymnastics

- Consistent development of strength, quickness, flexibility, coordination
- Learning advanced gymnastics skills and connections in easy and safe situations
- Skill performance stabilization of competition routines
- Steady increase in training amount and intensity
- Consistent participation in competitions

Peak Performance Period: the main training goal is specific training during the high performance age with peak performance in Championships

- Specific exercise for peak development of strength, power, flexibility, coordination
- Performance stabilization of highest difficulty skills and routines (overlearning)
- Steady increase in training intensity with a stabilization of training amount
- Success in Championships (State, Regional, National, International)

Transition Period: the main training goal is a change from an athletic to a healthy civil life-style

- Change in nutrition
- Change to life-long physical activities like jogging or swimming
- Change in life and professional focus

What these five periods have in common is that they overlap in time and content. Moreover, each period builds on what is accomplished in the previous period, and errors made in one period are difficult to compensate in the following period. Consequently, the sequence of

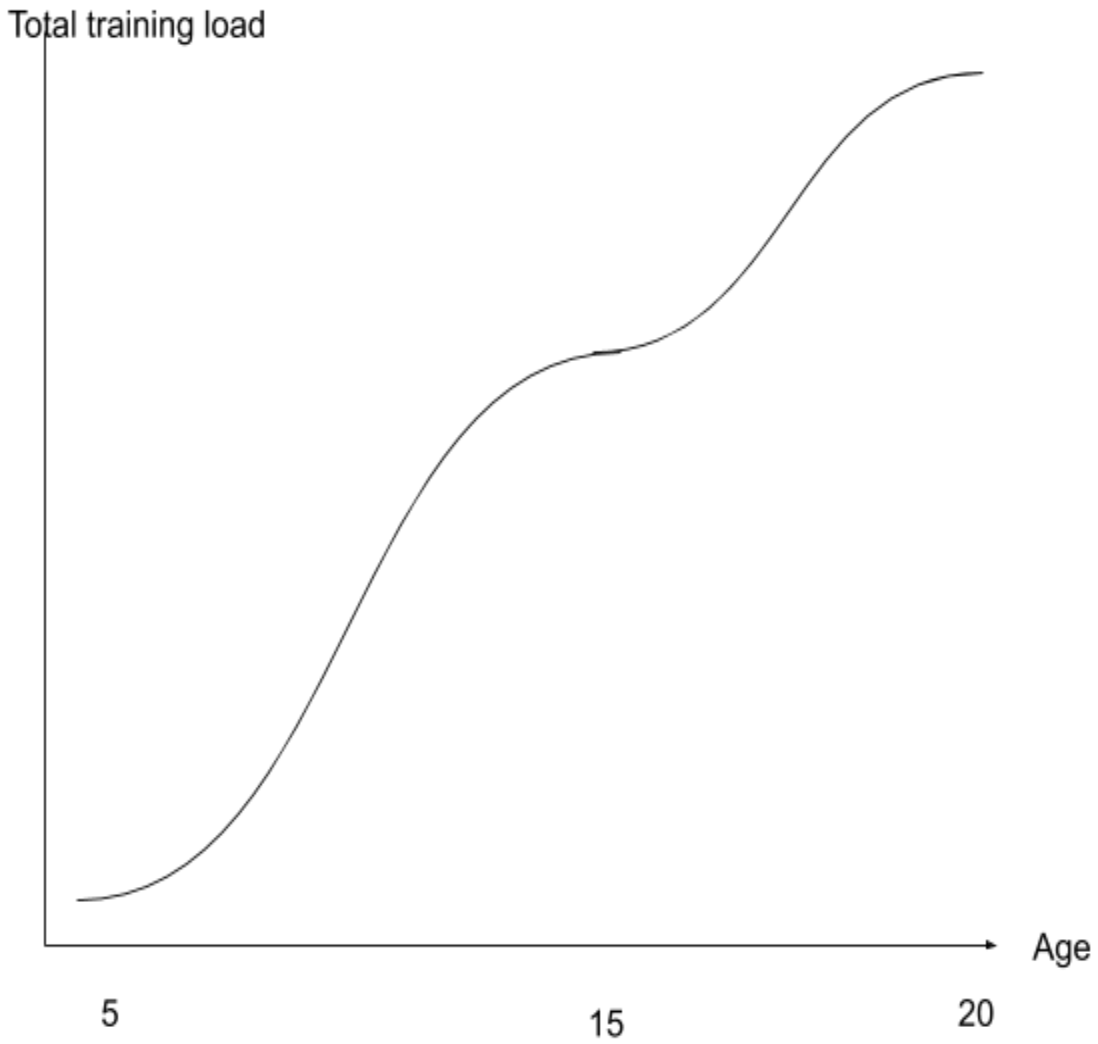
training goals cannot be changed. However, note that these career periods are only approximately associated with a certain age. How long each period lasts, will depend on

- The age of the athlete at the beginning of the first training period
- The peak performance age in gymnastics
- The talent or sensitivity to training of the athlete
- The gender of the athlete

Fig. 1. and 2. show the total training load during the career. Total training load is the sum of the amount of training and the training intensity. In gymnastics, training amount is typically measured in hours per week or total skills performed. Training intensity can be number of exercises per minute or the proportion of high difficulty skills to basic skills. Alternation between micro- and meso-cycles that are “heavy”, in other words heavy total training load, lots of exercise, and “intermediate”, and “easy” is necessary to insure that a gymnast who is training a lot adapts to her or his training, without over-training. Extra exercises that emphasize the capacity to be developed during a sensitive phase can be added during heavier cycles, and exercises not focused on this ability can be reduced during easier cycles. This may result in a plan that resembles in many ways Werchoshanski's periodization model of concentrated blocks (Werchoshanski, 1985). The mesocycles would consist of concentrated blocks of exercises directed at developing a certain ability during that ability's sensitive phase.

With the development of female and male gymnasts being so different, one might expect that the career periodization models would also be very different. However, there are in fact two aspects that are fundamental to any model. The first is that the girls' sensitive periods are usually more compressed in time than the boys'. The second is the age the gymnast, male or female, begins systematic training. An earlier start can permit a more distributed training process over time, while starting systematic training at an older age can require that the career training periods be more compressed in time, given a certain age of peak performance.

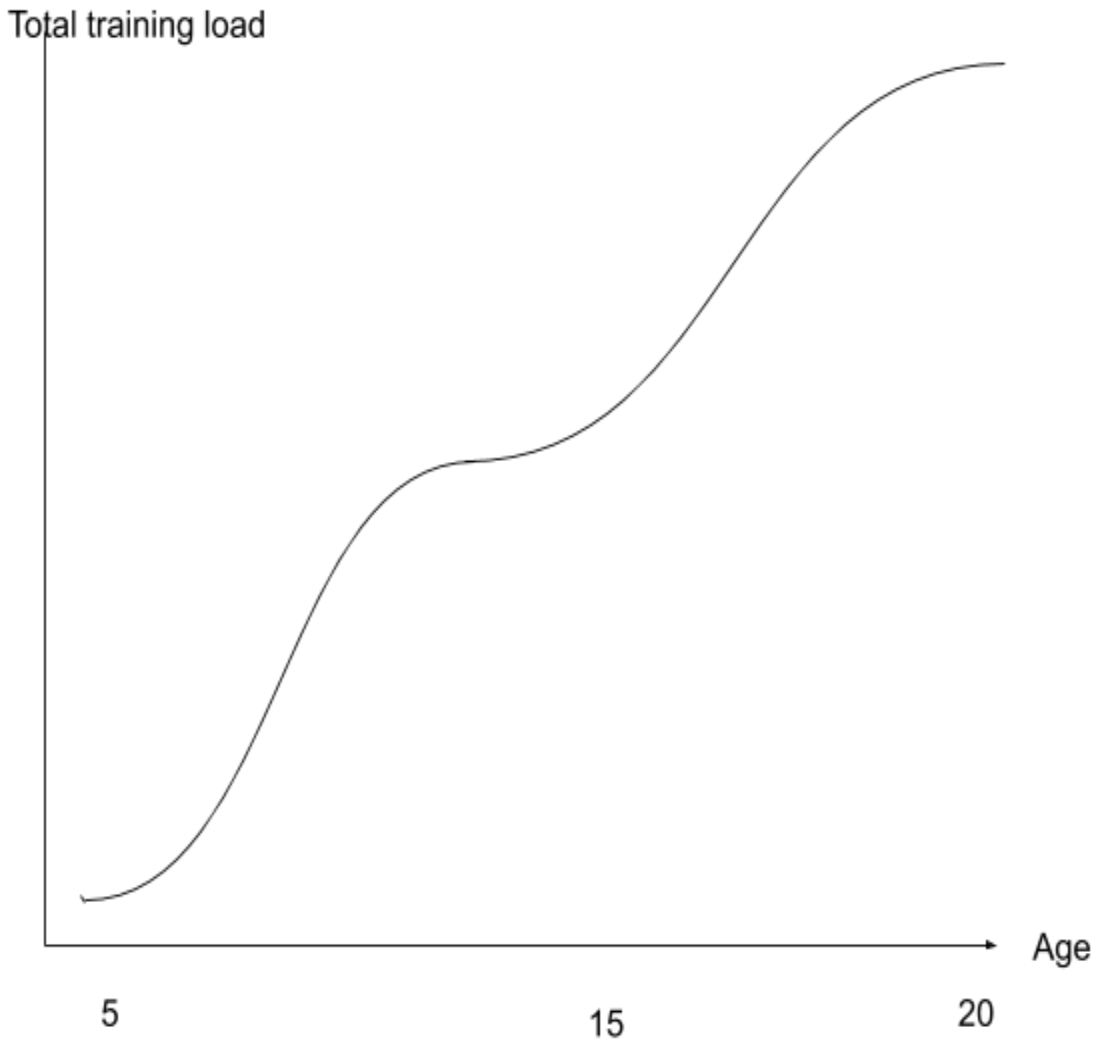
Notice in Figs. 1. and 2. the plateaus in rate of increase in total training load during puberty. The main means of increasing total training load to the left of the plateau is increasing training amount. This could be increasing hours in the gym and numbers of repetitions. The main means of increasing total training load to the right of the plateau is increasing training intensity. This would be increasing the gymnastics specificity of exercises, intensity of the strength training as a percent of maximum strength, and the difficulty of the skills and combinations. The plateaus in rate of increase in total training load during puberty are to avoid overloading the muscle-skeleton system during the pre-puberty growth spurt. Given that puberty occurs at a wide range of ages, not just different in males and females, the indicated ages are only given as an example that must be adjusted for the individual. The Transition Period is not shown because this period could begin at a wide variety of ages.



Foundation Period    Developmental Period    Performance Period    Peak Performance Period

Fig. 1. Ideal training load of a male gymnast. The indicated ages are only an ideal example.





Foundation Period    Developmental Period    Performance Period    Peak Performance Period

Fig. 2. Ideal training load of a female gymnast. The indicated ages are only an ideal example.

## CONCLUSION

The point of a career periodization plan is the maximum possible development of the gymnast. But such a goal will require the exploitation of the particularly sensitive periods during growth and development to training. During such periods, the gymnast adapts faster, and more profoundly to a given training. The increase in difficulty of acrobatic skills in gymnastics over the last 4-5 Olympic quadrenniums is based in part on mastery of basic skills that in turn, are based on highly developed coordinative abilities. The coordinative abilities are most thoroughly developed during sensitive periods that then become the basis for periodization of the gymnast's career. A gymnast's career ideally has four periods in the order Foundational Period, Developmental Period, Performance Period, Peak Performance Period and Career Transition Period. Attaining the training goals of each period, in their correct sequence, should enable a more thorough development of the gymnast.

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