

4.1 Training theory. Adaptation mechanisms

A sound understanding of the scientific basis of training is necessary to improve our understanding of sports and the adaptation processes that occur across all facets of an athlete's body. Two of the theories that best explain these adaptation processes that result from performing physical activity are:

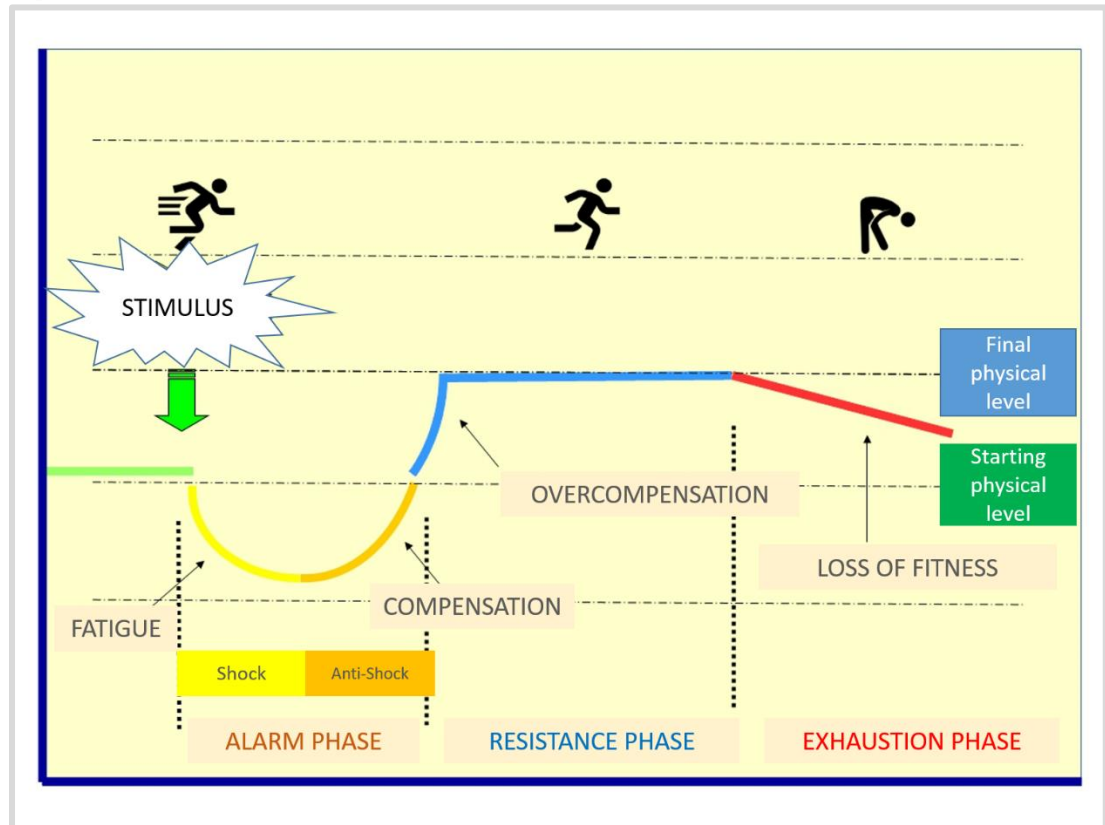
- General Adaptation Syndrome (GAS)
- Law of thresholds

General Adaptation Syndrome

This theory is based on the athlete's behavior in different situations that modify their state of equilibrium and generate different levels of stress. Described by Hans Selye in 1936, this theory states that the organism, when facing a stressful situation, reacts through a series of adjustments through which it attempts to restore balance (Wikideporte.com, 2014). Adaptation is divided into three main phases (see Figure 1):

- Alarm phase: the organism reacts to a stress situation with an imbalance (shock phase), followed by a rebalancing phase (anti-shock phase).
- Resistance phase: the body recovers and maintains a certain equilibrium, through which it gains a positive overcompensation and becomes more resistant to stimulation.
- Exhaustion phase: the organism does not attain equilibrium and ends up in a state of exhaustion. Excessive stress can lead to injury, or acute or chronic fatigue.

Figure 1: General Adaptation Syndrome applied to Fitness



Source: [Untitled image of the law of thresholds]. (u.d.). Retrieved from <http://bit.ly/2HfaSUX>

Law of thresholds

This law, also known as the Schultz-Arnold principle, is based on the threshold concept: a threshold is made up of the range of optimal stimuli in the intensity of a training session that will produce adaptations in the body. The range of optimal stimuli is normally between two intensities, called the adaptation threshold and the maximum tolerance threshold (see Figure 2).

Each athlete has a different threshold depending on variables such as age, sex, physical condition in addition to different thresholds for physical abilities: strength, endurance, velocity and flexibility. Based on each athlete's threshold, there are four types or classes of training stimuli—to make this explanation clear and relate it to team sports, let's establish that our team has four weekly training sessions that last between 75 and 90 minutes, plus a weekly competition in its microcycle:

1. Stimuli below the adaption threshold (due to the minimal stimulus, does not result in adaptation in the body). In our example, isolated trainings of

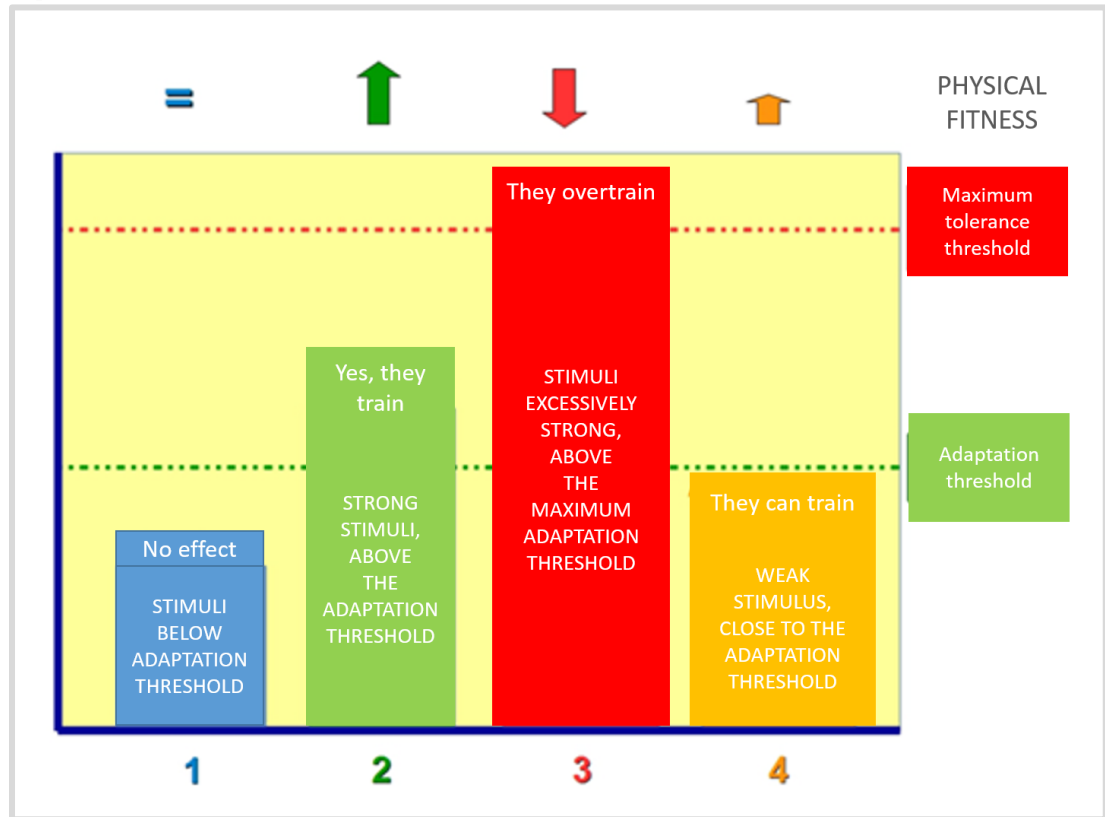
less than 30 min of group work will not produce enough stimulus to generate adaptations in the athlete.

2. Strong stimuli, above the adaptation threshold (due to its optimal stimulus, result in adaptation in the body and improve performance). In our team, the training sessions, which last between 60 and 100 minutes, will result in a positive adaptation and, typically, positive performance optimization for each of the players.

3. Excessively strong stimuli, above the maximum tolerance threshold (due to its high stimulus, results in overtraining which implies overexertion and causes a considerable state of fatigue). Used intermittently and sporadically, it can result in positive adaptations. To continue with the previous example, training sessions with the same average intensity, but of a much longer duration than usual (between 120 and 180 minutes), will cause a serious state of fatigue and, possibly, result in the athlete being overtrained.

4. Weak stimuli, close to the adaptation threshold (due to their proximity to the threshold, and the continuous and progressive repetition, they result in an adaptation in the body). From this example, this would be the case of more frequent training, but of a shorter than usual duration (between 50 and 60 minutes), whose stimuli are very close to the adaptation threshold, but which, due to their repetition and frequency, create positive adaptations in the player's body.

Figure 2: Law of thresholds



Source: [Untitled image of the law of thresholds]. (u.d.). Retrieved from <https://goo.gl/8DzQRi>

The principles of training can be defined as the set of rules and general guidelines used to plan, adjust and apply the training stimulus, in pursuit of the best possible adaptation of the athlete's body and the optimization of their performance. It is a concept more often associated with individual sports, but which also offers general training guidelines for team sports. The most relevant and necessary training principles in sports include:

Principle of generality or multilateralism: refers to the training session being global or generic, which means that it includes all of the sport's specific physical capabilities. This is closely related to how we understand team sports training. Variable, continuous and random practice from a multilateralism approach provide richer training stimuli for learning and performance optimization.

Principle of functional unit: refers to when the athlete works as a whole, and that this whole is much more than each of the parts. All structures (conditional, coordinative, cognitive, socio-affective, emotive-volitional, creative-expressive and mental) are totally related in any sports process, and we cannot train them in isolation as separate elements or compartments. Furthermore, if the training process is based on the principle

of functional unit, in addition to optimizing the performance of athletes across many structures, we will simultaneously facilitate their motor and cognitive skills.

Principle of continuity: refers to training that maintains continuity and periodicity over time. The different stimuli need to be applied with an appropriate interval of time between each, taking into account that, according to the preferential physical capacity, they must be spaced out to a greater or lesser extent to produce optimal adaptations in the athlete's body. However, optimal stimuli with discontinuity can be useless and even result in a detraining process when there are periods of prolonged inactivity after periods of optimal training.

Principle of progression: also known as the principle of gradual increase of effort, this refers to training that is undertaken in a gradual and progressive way, respecting the athlete's current physical fitness. With small progressive stimuli and with the necessary continuity, greater improvements in performance can be obtained, but the most important outcome is that these improvements last longer over time.

Principle of individualization: refers to training that is individually tailored to the athlete. Even in individual sports, two athletes with the same specialty at the same moment of the season, will have different levels of physical fitness, personal and professional circumstances, weight, anthropometries and prior experiences, just to name a few of the main characteristics that must be taken into consideration when implementing an individualized training plan. In team sports, for a long time training consisted of providing the same content to all team members but, especially in present-day high performance sports, a lot of attention is being given to individualized stimuli based on the athlete's current condition, both during optimizing and adjuvant training sessions.

Principle of optimal load and recovery ratio: refers to the alternation of optimal training stimuli and recovery processes. Depending on the intensity and each stimuli and the preferential physical capacity, there are optimal recovery periods. These can range from 24 hours (in the case of aerobic endurance training) to 48-72 hours (in the case of anaerobic resistance or maximum strength training).

Principle of specificity: refers to training of a specific character for most of the application time. Said specificity can be based on, firstly, the muscle groups and the motor patterns most used in the sporting specialty and, secondly, the training content most similar to or that is reproducible or preferred from the competition. The principle of specificity may not be as



relevant at early ages however in adults and high performance environments it is very important.

CONJECTURES ABOUT TRAINING

Within team sports, some principles of training are put into effect differently and can be substituted, implemented or modified as systemic conjectures. These conjectures, rather than being norms or rules, are derived from judgments or opinions based on the practical experience of well-known coaches in these sports. They contribute concepts to the practice that respond to the complexity of team sports and the competitive conditions of this environment:

Synchronous efficiency conjecture: refers to the commitment to identify the point up until which one (or several) training stimuli maintain the optimizing effect in their application on the same group of players. Based on variability and on this synchronic efficiency, for team sports, the norm is not to repeat an exercise more than three times with the same preference and the same assignments. The aim is to always look for new adaptations in the player.

Intrasystemic conjecture: when optimizing a system in a player's structure, a self-optimization (self-organization) of other systems in the same structure or in others can occur simultaneously. In our training tasks (preferential simulator situations [PSS]), one structure should be preferentially optimized, whilst others are favored at the same time. For example, we can use a circuit with preference for the conditional structure, where we incorporate technical (coordination) elements to achieve optimization in both structures.

Utility and temporary efficiency conjecture: it is important to know how much time in a session should be invested to optimize a certain system of a certain structure in order to be temporarily efficient. Following the idea that "a little bit of good is better", time should be used for optimization, without going over time or without providing sufficient time to achieve what we are really seeking to achieve in any training situation.

Hologrammatic conjecture: this refers to the requirement that each training unit should include the representation of all the elements of the game event that need to be optimized in a training session. Our biggest challenge is to get the most benefit out of each training situation, and to propose variables and structural superpositions in order to simulate all the game elements.

Synergistic conjecture: proposes practicing different combinations of content of training situations and their organizational strategies within the



programming, until synergic effects between them are found. Synergies between the different episodes of the same training session should be generated, as well as different sessions within the microcycle, to promote connections and interrelations in the contents.

Competence conjecture: training situations must be compatible and almost identical to the game event situations that we want as a model for our team in the competition. All the organizational strategies that are programmed should be in line with one of the conjectures, or with several of them, and should never go against any of them.

TRADITIONAL PLANNING VS TEAM SPORTS PLANNING.

Planning, periodization and programming

By planning, we mean the systematic and generalized development of a plan that contemplates, among other aspects, the training objectives, the main competitions, and all the training principles and conjectures, as previously discussed. Sports periodization, within planning, represents the partial intervals into which training is divided, in order to monitor the optimization of the athlete, and compile all the training and competition results. Programming is the operative form in which the periodization model is determined, the training work plans, contents, means and methods are organized and distributed, as well as the load distribution, expressed in volume and intensity values throughout the periodization.

The basic structures of training planning can be encompassed in different periods: multi-year, seasons, macrocycles, mesocycles, microcycles, training sessions, etc. Normally, these structures are designed with traditional planning in mind, typically for individual sports.

Microcycle: in most team sports, the basic structure is the microcycle (a period that normally takes place between 2 competitions), although it is traditionally understood as being one week. In high performance, the density and the number of weekly competitions can vary and, furthermore, the days of competition can vary, thus sometimes, within the microcycle, it is easier to see the structure of competition days (match day or MD) or the days before or after a match (MD + 1, MD - 4, MD - 3, MD - 2, MD - 1).

Mesocycle: in team sports, mesocycles usually cover the period of time between two important competitions (more important than a typical match). Traditionally, however, this period is understood as the time period of one month. In traditional planning, which has also been widely used in team sports and which is probably still used by elite coaching staff, the planning

model known as the contemporary or ATR (Accumulation, Transmutation, Realization) model is followed. The content of these models is organized into three different blocks or mesocycles: 1) accumulation; 2) transmutation; and 3) realization, moving from more general to specific contents and with a load tendency that moves from volume to intensity.

Macrocycle: both in traditional and contemporary planning, these periods are better known as the pre-season (period prior to the official competition season), competitive period (most important part, where all official team or individual competitions take place), and transition period (which is usually a period of reduced activity, where the athlete recovers from all the effort in the competitive period and restores levels to start a new season again).

Season: the season is the entire period that includes macrocycles, mesocycles, microcycles and training sessions during a sports year. In team sports, when we train, we usually set a series of main objectives for the entire course of the season.

Multi-year plan: in traditional and large-scale planning, there are also multi-year plans, which usually extend from two to four years and typically include cycles across age categories; and at the elite level, they include world championships, European or Olympic cycles.

MULTI-YEAR PLAN

SEASON

MACROCYCLE

MESOCYCLE

MICROCYCLE

TRAINING SESSION

TRAINING EXERCISE



Functions of planning

The following functions of planning, specific to team sports, were outlined by Paco Seirul-lo (2017):

- Define the training objectives, drawn from each phase of the personalized plan and corresponding to the specific moment of the player's sporting life, to adapt them to the individual.
- Describe training elements that are specific to the specialty and are derived from the structural characteristics of the same, which are considered the most efficient for the achievement of those objectives.
- Logical organization of the training elements and contents that have been chosen, all in accordance with the principles and laws of the supporting theories of reference.
- Design the sequence and quantification of the training load according to the competition and the associated importance for the player, who must be taken by those elements at different moments of the training process.
- Select the individual's systems where loads will be directed to control the configuration of their performance.
- Establish the most suitable types of training for each and every one of the systems previously selected, as well as the application time and its consequence.
- Have the valid control mechanisms in place to monitor all these processes and their effects on the athlete's different systems.
- Have technology that supports the assessment of the athlete during the competition to analyze the impact generated.

All these functions maintain the training process in a continuous state of review to continually adapt it to the personal needs of each player. (Seirul-lo Vargas, 1998)

TACTICAL PERIODIZATION (TP) VERSUS STRUCTURED TRAINING (ST)

In the realm of team sports, and more specifically in soccer, there are two up-to-date planning methodologies, based on the complexity of training and the competition in this sport. On the one hand, there is Vitor Frade's tactical periodization (TP). He is a professor at the Faculty of Sport of the University of Oporto, and his theories have been well represented in work by Tamarit (2013). On the other hand, there is Paco Seirul-lo's structured training (ST). He is a Barcelona INEFC professor and FC Barcelona (Soccer Club) physical trainer in handball and football for 20 years. The theoretical proposals have their differences but also some points in common, such as the following:

- They approach the athlete from a global point of view, based on the idea that the whole is more than the sum of its parts. The relationship and interaction between the different structures and elements that make up performance are considered especially relevant.
- They use specific training principles for team sports, where sometimes the usual laws, principles and planning concepts of individual sports cannot be applied:
 - Principle of complex progression: proposes a progression in the contents, which refers to the complexity within the principles of the model of the game.
 - Principle of specific horizontal alternation: proposes a series of contents that are given alternately during the session and the microcycle (morphocycle), based on three parameters related to muscle contraction (tension, duration and velocity regimes), in a way that guarantees the principle of an appropriate relationship between effort and recovery.
 - Principle of propensities: proposes the systematic repetition of game situations that can occur, or that we foresee could occur, for the players in the next match.
 - Principle of specificity or suitability conjecture: proposes undertaking different training situations (preferential simulator situations) that produce constant and continuous optimization in the player for the next competition, as well as the necessary adaptations depending on their delimitation and on the roles to be performed.

Content structuring. Morphocycle pattern (TP) versus structured microcycle (ST)

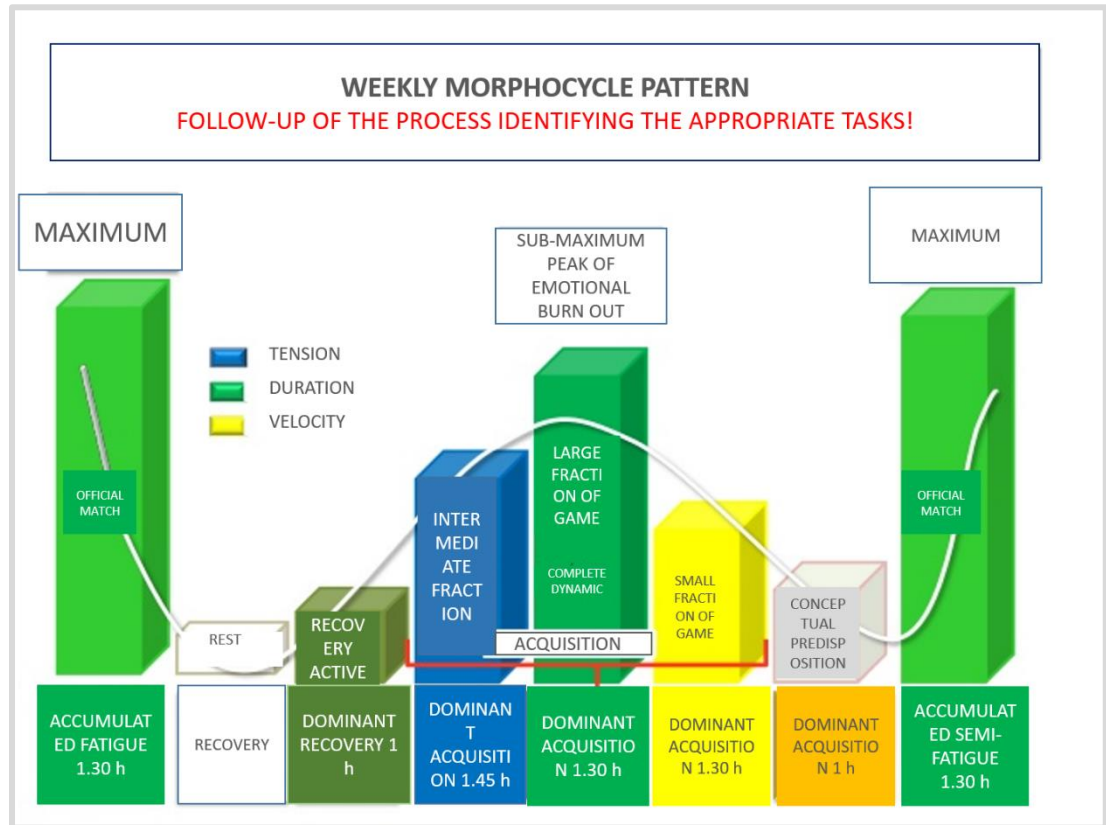
In tactical periodization, the standard morphocycle is the fundamental nucleus of the seasonal organization of training. Objectives revolve around preparation for the next game based on the analysis of the previous game (Arjol, 2012).

Within the weekly structure, two main phases are differentiated:

- Recovery phase: the two days following the previous game and the day before the next competition.
- Acquisition phase: the central days of the microcycle, in which the bulk of the training contents are worked on according to the principles and subprinciples of the game model.

The morphocycle format is identical or very similar over time and always uses the same training pattern, even with regard to the team's scheduled days off.

Figure 4: Weekly Morphocycle Pattern



Source: Espar, 2017, <https://goo.gl/rJZGx1>

Structured training (ST) is based on the fact that, in team sports, a team competes for 40 consecutive weeks, sometimes with one or two weekly competitions, and the athlete is subjected to maximum competition stress over an extended period of time. This load must be taken on as a specific and fundamental load within planning. Therefore, a training format is developed, the ST where the structured microcycle (SM) becomes the unit which allows for competition and is also how the different structures are modified during the week.

Within the weekly structure, four main phases are differentiated:

- **Restoration phase:** the objective is to restore the physical and mental effort used in the competition.

- **Implementation phase:** the objective is to facilitate preparation for the next game, so it focuses primarily on the introduction of new game concepts (defense or attack) depending on the opponent. To these new concepts, the specific needs of the team can be added based on the weak points from the previous match or the preparation for the next match.
- **Optimization phase:** the objective is to facilitate preparation for the next game, so it focuses primarily on the introduction of the game concepts already incorporated (defense or attack). These concepts are unique to our game model, our way of playing, those situations that make us recognizable as a team and that give us a feeling of belonging to a certain style.
- **Activation phase:** the objective is to facilitate the preparation for the next game by bringing together everything worked on during the microcycle. All the main situations during the week must be brought together and implement an adequate and effective activation so that the player efficiently recognizes the situations in competition.

Another distinguishing characteristic of this model is planning the SM sequences. Microcycles are normally planned three at a time and the load dynamic is integrated. We do not plan more than 3 microcycles, since all the dynamics must be implicit and related to each other. This is to ensure a horizontal and vertical relationship between the PSSs of the three planned microcycles, according to the calendar, the rival and the moment of the season. Once the three planning units are established, we can discuss SM using the conjectures (which are not traditional training principles) to identify the relationships that exist between the implementation and the optimization of the first and third week.

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