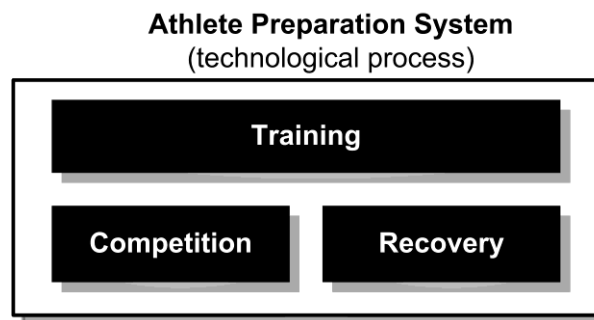


Usage of subjective indicators in monitoring and programming of training

Mladen Jovanović

Introduction

Process of preparing the athletes for competitions can be considered *complex adaptive system* ^[15, 17, 19, 21] that can be further divided to (1) **training**, (2) **competition** and (3) **recovery** sub-systems.

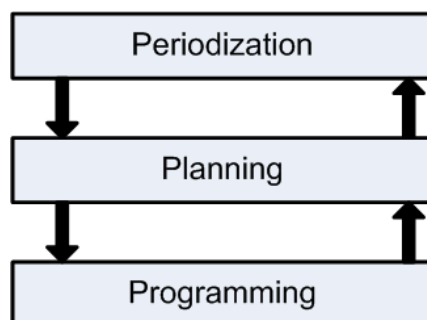


Coach is the person that utilize feed-forward and feed-back information to manipulate key constraints of this complex system with the aim of bringing it's state and behavior to the desired level (and at the desired time), mostly influencing it with *training stimulus* that is compromised of (1) **training workload** (intensity, volume, frequency, etc), (2) **training means or exercises** and (3) **training methods** ^[15,17,18]. This process of management is constrained by three factors, notably (1) **current state and performance**, (2) **outcome/performance/process goals** and (3) **context** ^[15,17].

The behavior of this system (both at the team level and at the individual level) or its performance is influenced by the following group of factors (that are addressed by training elements) ^[17]:

1. Technical preparedness
2. Tactical preparedness and decision making
3. Physical preparedness
4. Psychological preparedness and mental toughness
5. Athlete character and communicational skills
6. Strategy and game plan

The organization of the training process with the aim of bringing each of these elements to desired state (goal) can be seen through three levels: (1) **periodization**, (2) **planning** and (3) **programming** ^[18,19].



These three levels can be seen as different **zoom levels** of organization of the training process and each has certain set of principles that constraint it's organization. Three levels are interconnected and interrelated.

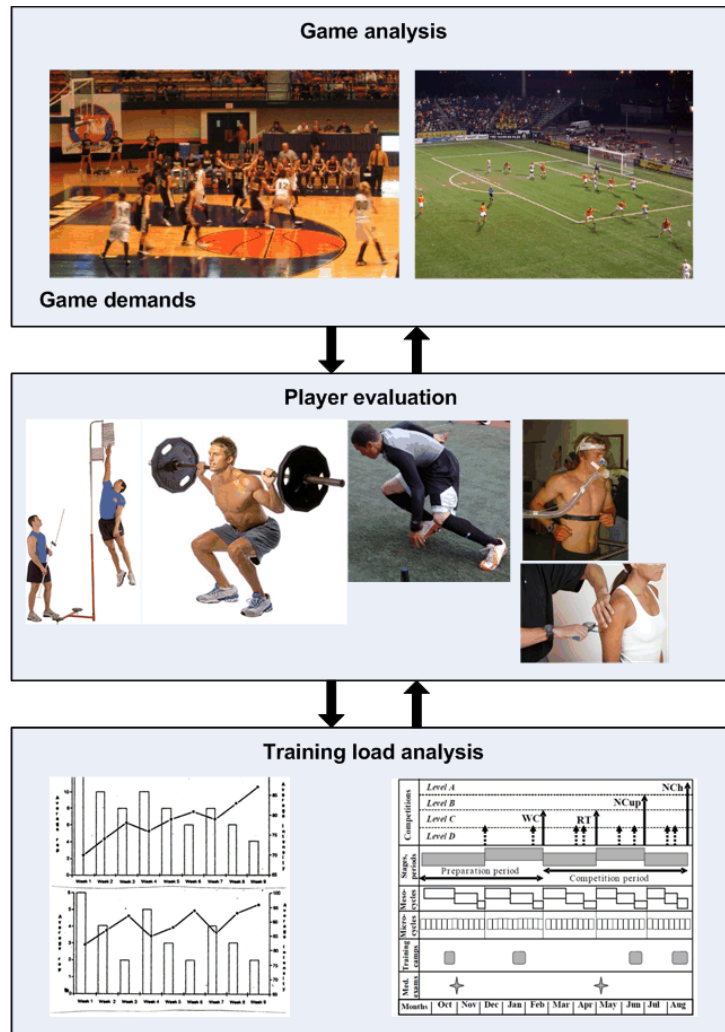
Coach needs to utilize flexible enough approach in the organization of the training process and it can be said that mentioned three levels have different *flexibility*, with the programming level being most flexible and periodization level being most rigid ^[15]. Flexibility is very important quality since the behavior of complex adaptive systems such as preparation process can be very unpredictable ^[10]. Mike Tyson used to say that “Everybody has a plan until he is punched in the face”, which pretty much sums up the problems of controlling and organizing the training process ^[21].

To achieve this flexibility, coach need to modify the training stimulus and training process in general according to the athletes reactions to training (adapt the training to the athletes, not *vice versa*) which are termed **training effects** ^[10, 11, 12]. Vladimir Issurin classifies training effects to the following groups:

1. Acute training effects
2. Immediate training effects
3. Cumulative training effects
4. Delayed training effects
5. Residual training effects

For further information on these training effects interested reader is director to the work of Vladimir Issurin ^[10, 11, 12].

To assess and evaluate these training effects, coach can use different kinds of (1) **monitoring**, (2) **testing** and (3) **competing and competition analysis** ^[15]. This kind of analysis can yield a cause-and-effect laws that can be used to guide the training process in the future and expand practical or empiricism knowledge. This concept is depicted in the following picture



The rest of this article will concentrate on monitoring of the subjective indicators of acute and immediate training effects and its usage as a feedback in programming the training process.

Acute training effects

The changes occurring in athlete's state during the training or exercise determine acute training effects ^[10]. Three groups of measures characterize the acute training effect: (1) **indicators of training workload** (such as intensity, power, volume, and speed), (2) **physiological**

variables (such as heart rate, blood lactate, VO₂) and (3) **psychological indicators** (like *affective loading* and *rate of perceived exertion* – RPE or *intensiveness*)^[10].

We are going to expand further on the usage of psychological or subjective indicators of acute training effect.

Since the brain integrates all the information from the periphery of the body and the state of the body homeostasis^[3], humans are basically equipped with the best monitoring tool – their brain. Numerous quantification systems developed over the years with the aim to assess this *subjective feel* and one of the most famous is the Borg’s scale or RPE – rate of perceived exertion. Although the original scale was from 6 – 20, new modified scale from 0-10 is more understandable and more used today. Research shows high reliability of the RPE scale and its high correlation to physiological variables (heart rate and blood lactate accumulation) and training workloads, which basically supports usability of monitoring subjective feel in training^[1,5,9,13,24]. Indeed, RPE is well known to be related to chest and active mass muscle parameters, as well as heart rate, oxygen consumption, respiratory rate and minute ventilation, blood lactate concentrations and muscular strain^[3]. Importantly, no single physiological parameter predicts the RPE during exercise indicating that this is complex system phenomena^[3].

Advanced athletes are famous of being able to re-adjust their training workload based on the feel, and teaching them over time to trust their own feelings is a way to ‘teach them how to fish’, instead of using rigidly programmed training session. It is shown that abilities oscillate over the training period mostly influenced by sleep, nutrition, social factors, fatigue, stress, travel, competitions, emotions and such, so we can never know in advance how the performance is going to be on a given day. Being rigid in programming is not a way to utilize and adapt to this normal performance variability, instead being more flexible and allowing the athlete to self-organize the training based on couple of simple rules. That is how individuality in training is achieved to a certain degree.

There are numerous ways to achieve the tracking of subjective indicators, most notably the **RPE** and **PR**. RPE stands for rating **of perceived exertion** and PR stand for **perceived readiness**.

Michael Tuchscherer, a coach and power lifter developed a whole system of training programming based on usage RPE^[26]. So, instead of giving certain weight percentages, number of sets and reps, Mike utilize couple of simple rules and RPE to **auto-regulate** (self-organize) the training based on the feel^[18,26]. Exploring Mike’s system of strength training is time well spent.

Perceived readiness is also a scale (in the research it is from 7-1, but it can be from 0-10, 0-5; the key here is to pick the scale and stick to it) that is used to quantify the recovery during

the training session and auto-regulate recovery duration ^[7]. For example in planning the interval training session, instead of prescribing fixed work/rest values or using HRs, the coach can prescribe doing 1000m intervals at RPE 8 of 10 (there is a difference between starting-RPE and ending-RPE during the interval due fatigue accumulation ^[3]) and restarting the intervals when PR gets to 4 of 7 (where 7 is being unable to exercise, and 1 is being fully recovered) ^[7].

This kind of subjective workload programming is currently emerging as research topic and in authors opinion it is a way to go, since it teaches athletes to be more responsible for their own training and giving the freedom and control a certain aspect of training which can improve their long term compliance and adherence, even reduce physiological stress on the same training workload ^[22], and probably reduce the overall (daily, weekly) training workload (see *session-RPE*). One new research even shows better strength training results by utilizing auto-regulatory training ^[23]. Still, this kind of workload programming is still young, but again it allows taking into account day to day variability in preparedness level ^[18, 26]. Author suggests that the time has come to finally switch from dogmatic-linear systems to more pragmatic complex systems¹ that underlie our training philosophies and guide our training decisions, planning and programming.

One interesting way of using subjective indicators of acute training effect is **session-RPE**, a novel method ^[1, 2, 5, 8, 9, 13, 20, 24] to monitor and track training load first formulated by Foster *et al* ^[8, 9]. Since monitoring training workload in team sports using indicators of training workload and physiological variables is very hard and not very practical², Foster proposed a method of tracking down the session-RPE or subjective perception of the *internal workload* of the whole session. The key to utilizing this method of monitoring training workload is to avoid the effect of the exercise done last, thus the session-RPE is taken after 30min post workout, so that athletes can reflect on the whole workout. Sometimes, this is not practical, and the author again suggest picking up the time frame and sticking to it (at least 15min post workout).

Similar to RPE during training, session-RPE is taken by answering a simple question “**How was your workout?**” and pointing to a scale. **Training load** is calculated by multiplying session-RPE and training duration in minutes (including warm-up).

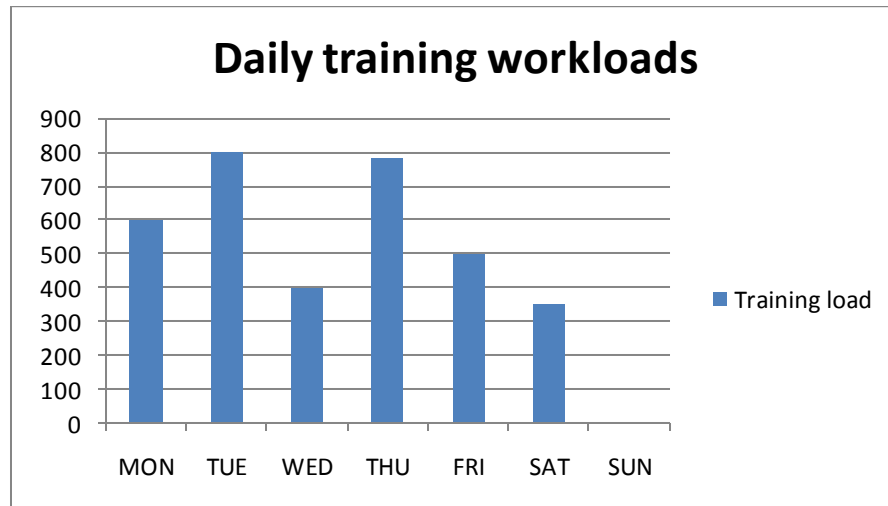
$$\text{Training load} = \text{Session-RPE} \times \text{Training_Duration (min)}$$

¹Complex Systems is a new approach to science that studies how relationships between parts give rise to the collective behaviors of a system and how the system interacts and forms relationships with its environment. For more information on complex systems please check the following links:

1. http://en.wikipedia.org/wiki/Complex_systems
2. http://www.scholarpedia.org/article/Complex_systems
3. http://en.wikipedia.org/wiki/Complex_system

² Modern technology allows more easier monitoring of training workloads (distance covered, average speed, time/distance spent at different speed levels, etc) and physiological variables (HR, bLA, VO₂, etc), although it is still very expensive and un-practical compared to usage of subjective indicators

For example if session-RPE was 8/10 and the training duration was 90min, then training load is 720 (AU). Using this simple method of monitoring, weekly training load can be easily depicted and monitored. If a given training day has a multiple training sessions, they can be depicted as individual or summed as total daily workload. Data can be showed for an individual athlete or for the whole team.



From a weekly training load, following numerical data can be calculated:

- **Weekly training workload** or the sum of daily workloads over the week
- **Training monotony** was calculated from the *mean training load* divided by the *standard deviation* of the training load over a 1-week period and basically represents daily variations in training workload (*hard-easy, hard-medium-easy training days, etc*). It is shown that training monotony is one of the most important factors inducing overtraining ^[8]
- **Training strain** or a product between weekly training load and training monotony

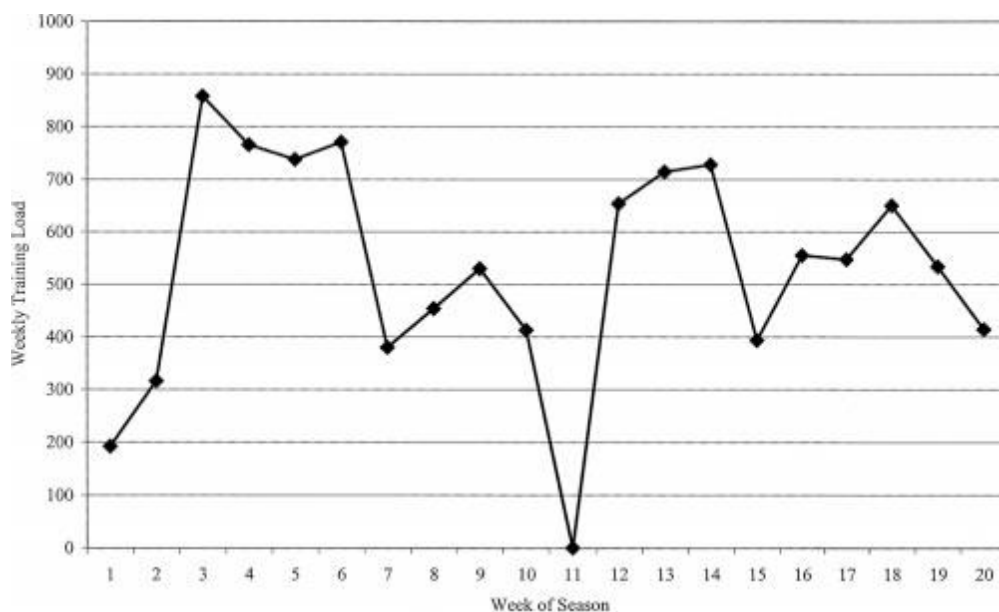
It is important to stress that it is hard (and not even smart) to compare different types of workouts (i.e. strength training, glycolytic power/capacity, aerobic training, technical training) in terms of session-RPE and workloads based on subjective feeling. Or in other words, it is impossible to say that strength workout with 450 [AU] is easier/harder than aerobic workout with 550 [AU]. Those are *apples and oranges* and they stress different physiological systems (i.e. neuromuscular vs. cardiovascular). What can be done in this way is to compare the workouts of the same type³ and/or to compare the microcycles of the

³ Even in the case of workouts of the same type, comparing session-RPE and training workloads (in terms of what is easier/harder) is a complex thing to do. For example, 8 sets of cleans can seem more easier compared to a 2 sets of heavy dead lifts, or 3 circuits of barbell complexes. Parameters such as total motor unit recruitment in a given exercise, weight on the bar in terms of percentage of 1RM, proximity of failure, speed, recovery period, etc can

same/similar structure and aim/goal. The take home message is that it is very complex to say that this workout or this microcycle is harder/easier than that one, in terms of relying solely on session-RPE and training workload calculations based on it. Anyway, subjective monitoring of this kind is not enough *per se* for this type of evaluation, because “full picture” can be seen only with monitoring indicators of training workload (i.e. weight on the bar, rest duration and quality, velocity, distance, etc) and/or physiological indicators during the workout. Having all or most of that data can provide more insight for evaluations.

One interesting trend worth mentioning was observed in the research done by Manzi *et al.* [24] where players with higher scores in [Yo-Yo Intermitent Recovery Test](#) L1 showed lower mean individual session-RPE indicating that the more endurance-fit players experienced a lower psychological/subjective workload to the same training sessions. Practically this means spending some time improving aerobic endurance and/or work capacity may yield long-term benefits (even if sport is not 'aerobic' *per se*, although this issue is worth an article in itself) by decreasing subjective indicators of the same training workloads and/or allowing training stress to be increased (which can be spent on developing technique skills or tactical skills or what have you) without negative effects. In strength and conditioning world where everybody is focusing on *high intensity interval training* (HIIT) and *repeated-sprints ability* (RSA), this is a point worth considering and usually forgotten.

Mentioned variables resulting from simple tracking of session-RPE over the week/microcycle period, can be depicted over the longer period of time, for example one season or training year.



define different training aim and thus different physiological systems that are stressed, so session-RPE and training workloads cannot be easily compared in those circumstances in terms which workout is harder/easier.

This data can be used for two key purposes: (1) **avoiding overtraining and injuries** and (2) **programming and adjusting/correcting the training workload**.

Numerous researches have showed a correlation between injury and illness rates along with overtraining incidents with the mentioned variables (weekly training workload, training monotony, training strain) resulting from simple tracking of session-RPE [2, 6, 8, 25]. Thus, monitoring of session-RPE for a single player and for the whole team represent **powerful weapon of injury prevention** and control/feedback of training workloads (comparison of planned workloads versus achieved). Not to say that you can prevent overtraining, underperformance (depressed mood state and emotional disorders [3]), injury and illness just by monitoring session-RPE, but rather by taking the corrective actions based on that data and the training plan and program.

A paper by Baron *et al.* [3] even presents new model of monitoring emotional states with the aim of improving training process and avoiding overtraining and underperformance. The summary of decades long and millions of dollars worth research on overtraining can be summated by the simple question „*How are you feeling today?*“ (see section on immediate training effects), since psychological indicators are the first one affected, before performance drop or even before changes happen in the physiological variables [3]. Indeed, RPE appears to be most sensitive parameter for identifying overtraining [8], because physiological systems are more *robust* and probably become affected at a later stage in the overtraining process [3]. Overtraining may also influence the evolution of positive affective and affective loading responses, which might also be used to adjust training before underperformance occurs [3].

Currently, a lot of coaches are concerned with implementation of **prehab training** (pre-rehabilitation training), single leg training, unstable surfaces, vibrating surfaces and other modern training gadgets, without seeing the big picture first, and that is good planning and programming of training and simple and effective monitoring of training workloads and adjustment based on that feedback data. Joel Jamieson, author of “Ultimate MMA Conditioning” book [14] and strength and conditioning coach of some of the most elite MMA fighters, in a private conversation with the author of this article stated very clearly that:

“Strength and conditioning should be focused on improving performance and that happens by improving energy production and utilization through the systematic development of the biological systems. Injury prevention is most effectively managed through the proper applications of volumes and intensities of a well designed program because in my experience, most injuries tend to occur when there are a breakdown in the body’s adaptive abilities, not because some joint or joints didn’t have enough ROM or stability.” – **E-mail received 5th July, 2010.**

Further utilization of monitoring of acute training effects by utilizing session-RPE is in control and adjustment of training workload. By simply monitoring session-RPE and resulting variables, a coach can control the implementation of training plan and program. Depending on the type of training session and training microcycle ^[11, 12, 18] a coach can expect to see certain types of daily and weekly training workloads assessed by session-RPE. This way a coach can compare what he wanted to achieve in terms of loading and what he actually achieved. Thus, session-RPE represent a very powerful tool in controlling, adjusting and correcting training program.

By utilizing **Peaking Index (PI)** defined by Tudor Bompa ^[4], which is basically an index of peak shape or sport form ^[16], coach can plan in advance training loads based on the competition calendar. Based on Tudor Bompa ^[4]:

- **Peaking index 5** is 50% preparedness, characteristic of the transitional period. Training workloads are very low due the rest and recovery goals.
- **Peaking index 4** is 60% preparedness, characteristic of the preparatory period when athletes are not yet ready to play. Training workloads are the highest here, and since the fatigue is highest here athletes are not yet ready to play.
- **Peaking index 3** is 70-80% preparedness typical for friendly games and games against weaker opponents. Training workloads are still high/medium here, and the training is still directed toward improving preparedness. Fatigue is medium.
- **Peaking index 2** is 90% preparedness characteristic of the period and competitive games against opponents from the top of the table. Training workloads are medium level and fatigue is in medium/low level
- **Peaking index 1** is 100% preparedness and is characteristic for Play-off periods, when peak form/shape is achieved. Training workloads are lowest and based on a concepts of peaking ^[4, 11, 12] which allow fatigue to dissipate and express the full preparedness.

Using this simple five numbers, coach can plan the season and priorities in advance and thus training loads for each period, and by using session-RPE he can control improvisation of the training plan and program.

In a very interesting article, Kelly and Coutts ^[20] presented very simple and effective method to plan training workloads during the season and control of it improvisation based on session-RPE. Training workloads are planned in advance based on (1) prediction **of the match difficulty**, (2) **match location** and travel and (3) **training days** between matches. Based on this model, training workload oscillates during the season based on the mentioned three factors with match difficulty being the one with greatest weight. This provides variations of training and undulations of training workload. In author's opinion, this model provides great solution to planning and programming training in team sports, since traditional ideas on 'peaking' are not

applicable during the team sports with very long season, except for the play-offs. Further explanation of practical utilization of Peaking Index, Kelly and Coutts model in periodizing, planning and programming training process would demand specific article, and it will be not addressed in more detail in this one.

By monitoring **immediate training effects**, besides acute training effects that are already covered, prevention of injury, illness, overtraining and possibly staleness and under-performance based on planning, control and correction of training workloads can be achieved with more precision and ease, and provide further data.

Immediate training effects

The immediate training effects arise as a result of summation of acute training effects from several exercises ^[10]. Or in other words, immediate training effects represent changes in body state resulting from a single workout and/or a training day ^[10].

Evaluation of immediate training effects is an essential part of athletes' preparation ^[10]. According to Vladimir Issurin ^[10, 11, 12], assessment of immediate training effects is based on the following indicators:

Characteristics	Indicators
Total amount of training load per session/day	Total mileage, mileage of intense exercise, number of lifts, throws, net time playing, etc
Athlete's subjective response	Sleep, appetite, general activity, muscle soreness, level of fatigue, willingness to train, etc
Objectively measured response of the athlete	Resting HR in the morning, heart rate variability, biochemical analysis (blood urea, glucose and CPK) after a working day, changes in test results (vertical jump, tapping frequency, grip strength), body weight, etc
Coach's pedagogical estimation	How the executed work corresponded to that training program: completely corresponds, mostly corresponds, far from complete, failure of daily program

Although there are certain advances in the usage of certain monitoring tools and technology, like heart rate, heart rate variability, [Omega Wave](#), performance assessment (vertical jump, grip strength, reaction time, tapping frequency) and biochemical assessment (blood urea, CPK, testosterone, cortisol, epinephrine, etc), in evaluation of immediate training effects on various physiological sub-systems (neuromuscular and CNS, endocrine, cardiovascular, respiratory, metabolic, etc), we are going to expand more on the subjective

responses. For further information, curious reader is directed to the work of Vladimir Issurin [10, 11, 12].

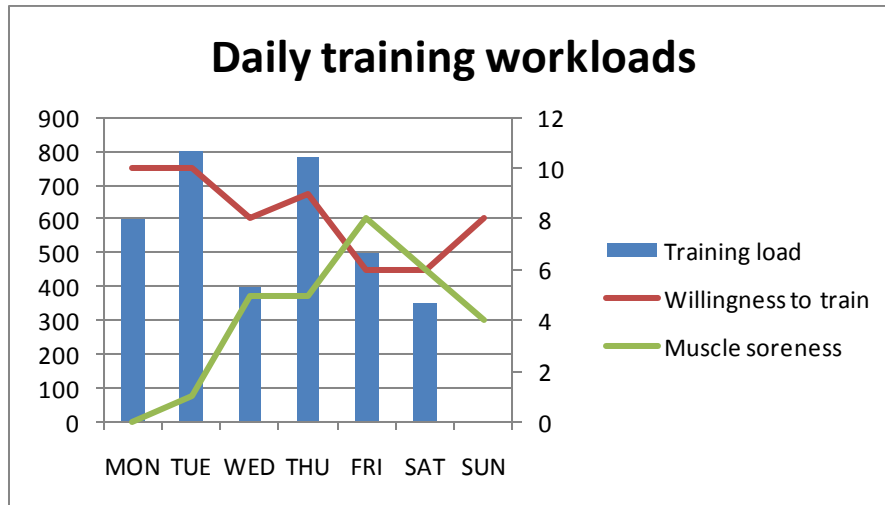
Examination of athletes' subjective responses is the cheapest, most readily available and most informative way to characterize immediate training effects [10]. The most widely used subjective estimates usually pertain to sleeping, appetite, general activity, and willingness to train [10]. Muscle soreness, self estimation of techno-tactical work, etc, can provide relevant indication of training effect [10].

Similar to subjective indicators of acute training effects, subjective indicators of immediate training effects can be also used for two main purposes: (1) **avoiding overtraining and injuries** and (2) **programming and adjusting/correcting the training workload**.

As already stated, the summary of decades long and millions of dollars worth research on overtraining can be summated by the simple question „*How are you feeling today?*“, since psychological indicators are the first one to be affected, before performance drop or even before changes happen in the physiological variables. Since no single physiological parameter predicts the subjective indicators of immediate training effect, similar to RPE and subjective indicators of acute training effects, this indicates that the subjective response to immediate training effects are complex system phenomena, which basically means they integrates all the physiological sub-systems. In more practical terms, this means really good usability of subjective indicators of immediate training effect since they provides the big picture of the athletes' state, but on the other hand, they demands further examination (by using performance and/or biochemical assessment) to clarify which physiological systems are affected by immediate training effects and what is the real cause.

The keys to usability of the subjective monitoring of immediate training effects are simplicity and quickness. Asking one or two simple, short and quick questions before a workout or in a morning can yield overall state of the athletes' readiness. In his books, Vladimir Issurin [11, 12] utilized the following two indicators: (1) **willingness to train**, and (2) **muscle soreness level**. Scale from 0 to 10, as in session-RPE, can be used to assess these two indicators. Sometimes, following through with more questions (sleep duration, quality of sleep, appetite, location of soreness, etc) can yield more precise data, which can be all tracked if needed.

Coach can utilize this kind of data to adjust and correct the training workloads and allow flexible programming [10], based on athletes reaction. If we depict hypothetical results of evaluation of willingness to train and muscle soreness to already depicted daily workloads graph, we may get something like this:



Based on such data, coach can modify/adapt the training program and put the key workouts of a microcycle where the athlete is the most willing to train and with minimal soreness levels.

It is normal to expect different soreness levels based on the training type along with total workload. For example, eccentric exercises are shown to induce muscle soreness, thus higher volume of this kind of exercise can yield greater score in muscle soreness indicators. Further, different types of microcycles (restoration, adjustment, loading, impact, precompetitive, competitive), and mesocycles (or training block) ^[11, 12, 18] are expected to induce higher levels of muscle soreness or lower levels in willingness to train indicators due different level of workload and/or different level of training emphasis. There is nothing wrong or good to it; the key is to utilize the feedback provided by subjective indicators of immediate training effect to adjust and correct training planning and/or programming based on the what wants to be achieved.

It could be further expanded that on different levels of Peaking Index ^[4], mentioned earlier in this article, different levels of subjective indicators of acute and immediate training effects could be expected. In the following table there is a gross oversimplification of the average levels of preparedness, fatigue, weekly training workloads, willingness to train and muscle soreness during different peaking indexes over the training season that should provide a general idea what to expect:

Peaking Index	Preparedness level	Fatigue	Weekly training workload	Willingness to train	Muscle soreness
5	<50%	Low	Low	(progress) Low to High*	(progress) High to Low*
4	50-60%	High	Very high, Progressively	High	Medium-High
3	60-80%	Medium	High		Medium
2	80-90%	Medium-Low	Medium	High	Low
1	90-100%	Low	Medium-Taper	Extreme	Low

* Willingness to train is low and the muscle soreness is high during the Peaking Index 5 because of the fact that competition season is over and athletes need rest and recovery.

Conclusions

Based on the research provided, subjective indicators of acute and immediate training effect provide excellent and simple feedback data that coaches can use to adjust training workloads to achieve pre-defined goals and to avoid overtraining, injury, underperformance and illness. More data is needed to provide practical utilization of subjective indicators in planning, programming and adjusting training. Anyway, subjective indicators provide very fruitful area of both the research and practical application.

References:

1. **Alexiou, .H**, Coutts, A.J. [A comparison of methods used for quantifying internal training load in women soccer players](#). *Int J Sports Physiol Perform*. 2008 Sep;3(3):320-30.
2. **Anderson, L.**, Triplett-McBride, T., Foster, C., Doberstein, S., Brice, G. [Impact of training patterns on incidence of illness and injury during a women's collegiate basketball season](#). *J Strength Cond Res* 17: 734–738, 2003.
3. **Baron, B.**, Moullan, F., Deruelle, F., Noakes, T.D. [The role of emotions on pacing strategies and performance in middle and long duration sport events](#). *Br J Sports Med*. 2010 Jun 17.
4. **Bompa, T.**, Haff, G. [Periodization: Theory and Methodology of Training 5th edition](#). Human Kinetics. 2009.

5. **Brink, M.S.**, Nederhof, E., Visscher, C., Schmikli, S.L., Lemmink, K.A. [Monitoring load, recovery, and performance in young elite soccer players](#). *J Strength Cond Res*. 2010 Mar;24(3):597-603.
6. **Brink, M.S.**, Visscher, C., Arends, S., Zwerver, J., Post, W.J., Lemmink, K.A. [Monitoring stress and recovery: new insights for the prevention of injuries and illnesses in elite youth soccer players](#). *Br J Sports Med*. 2010 May 29.
7. **Edwards, A.M.**, Bentley, M.B., Mann, M.E., Seaholme, T.S. [Self-pacing in interval training: A teleoanticipatory approach](#). *Psychophysiology*. 2010 Jun 1.
8. **Foster, C.** [Monitoring training in athletes with reference to overtraining syndrome](#). *Med Sci Sports Exerc* 30: 1164–1168, 1998.
9. **Foster, C.**, Florhaug, J.A., Franklin, J., Gottschall, L., Hrovatin, L.A., Parker, S., Doleshal, P., Dodge, C. [A new approach to monitoring exercise training](#). *J Strength Cond Res*. 2001 Feb;15(1):109-15.
10. **Issurin, VB.** [Generalized training effects induced by athletic preparation](#). *J Sports Med Phys Fitness*. 2009. 49:00-00.
11. **Issurin, VB.** [Block Periodization](#). Ultimate Athlete Concepts. 2008.
12. **Issurin, VB.** [Principles and basics of advanced athletic training](#). Ultimate Athlete Concepts. 2008.
13. **Impellizzeri, F.M.**, Rampinini, E., Coutts, A.J., Sassi, A., Marcora, S.M. [Use of RPE-based training load in soccer](#). *Med Sci Sports Exerc*. 2004 Jun;36(6):1042-7.
14. **Jamieson, J.** [Ultimate MMA Conditioning](#). 8WeeksOut.com. 2009.
15. **Jovanović, M.** *Training: Planning and Programming. Seminar Paper*. Faculty of Sports and Physical Education, Belgrade. 2005.
16. **Jovanović, M.** [The sport form phenomena](#). PowerDevelopmentInc.com. 2006.
17. **Jovanović, M.** [Physical Preparation for Soccer](#). SoccerSpecific.com. 2007.
18. **Jovanović, M.** [Planning The Strength Training](#). StrengthCoach.com. 2009.

19. **Jovanović, M.** *What the heck is Periodization anyway?* ReactiveTrainingSystems.com. 2010. [Unpublished]
20. **Kelly, V.G.,** Coutts, A.J. [Planning and Monitoring Training Loads During the Competition Phase in Team Sports](#). *Str Cond J*. 2007, August; 29(4):32-37.
21. **Kiely, J.** *Periodization, planning, prediction: And why the future ain't what it used to be!* UKA.org.uk. 2010.
22. **Lander, P.J.,** Butterly, R.J., Edwards, A.M. [Self-paced exercise is less physically challenging than enforced constant pace exercise of the same intensity: influence of complex central metabolic control](#). *Br J Sports Med*. 2009 Oct;43(10):789-95.
23. **Mann, J.B.,** Thyfault, J.P., Ivey, P.A., Sayers, S.P. [The effect of autoregulatory progressive resistance exercise vs. linear periodization on strength improvement in college athletes](#). *J Strength Cond Res*. 2010 Jul;24(7):1718-23.
24. **Manzi V.,** D'Ottavio S., Impellizzeri F.M., Chaouachi A., Chamari K., Castagna C. [Profile of weekly training load in elite male professional basketball players](#). *J Strength Cond Res*. 2010 May;24(5):1399-406.
25. **Putlur, P.,** Foster, C., Miskowski, J.A., Kane, M.K., Burton, S.E., Scheett, T.P., McGuigan, M.R. [Alteration of immune function in women collegiate soccer players and college students](#). *J Sports Sci Med* 3: 234–243, 2004.
26. **Tuchscherer, M.** [The Reactive Training Manual](#). ReactiveTrainingSystems.com

Recommended readings

1. **McDonald, L.** [Overtraining, Overreaching and all the Rest](#). BodyRecomposition.com. 2010.
2. **Valle, C.** [DEVIL'S ADVOCATE: ILDING SPEED DEMONS PART 1](#). EliteFTS.com

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