MLADEN JOVANOVIĆ

HIIT MANUAL

HIGH INTENSITY INTERVAL TRAINING AND AGILE PERIODIZATION

EDITED BY
BRYAN MANN PHD
MATT THOME MS

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www.complementarytraining.net

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High Intensity Interval Training and Agile Periodization

Mladen Jovanović

Edited by Matt Thome MS and J. Bryan Mann PhD

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Testimonials

'HIIT Manual is essential reading and offers a practical guide with excellent examples on how to address long standing issues with individual and team conditioning. A must read for anyone serious about working in the world of sport.'

Tony Strudwick (PhD)
Head of Performance
Football Association of Wales

'Mladen has put together a unique and comprehensive manual for HIT training. This Manual provides the practitioner with practical solutions based on the very latest HIT research. It really is the complete guide for HIT training for all athletes'

Darren Burgess (PhD)
Director of High Performance
Arsenal Football Club

'Mladen has done a lot of work to consolidate all the literature and put it in a way to give the practitioner a practical reference, lay of the land and tool to carry out the best HIIT for your group. I am constantly using this resource to help me plan and write my teams and athletes programs'

Darcy Norman
Director of Performance
AS Roma
Fitness/Rehab Coach, Performance Data Analyst
Die Mannschaft - German National A Team (Men)

To my son Nikša.

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HIT vs HIIT

When referring to **H**igh **I**ntensity **I**nterval **T**raining, coaches and researchers usually use the **HIT** acronym, although **HIIT** is used interchangeably. The original title of this manual was "HIT Manual", but together with the editors and publisher, we have decided to use "HIIT Manual" instead. The main reason is to differentiate this manual from books on *High-Intensity Training* (HIT), which is a form of strength training popularized in the 1970s by Arthur Jones, the founder of Nautilus (Source: Wikipedia).

The acronym HIIT is used only in the title of this manual, and everywhere else in the text, the acronym HIT is used to refer to High Intensity Interval Training.

Introduction

You have probably been struggling with finding a one-stop-shop guide on HIT conditioning for your athletes. I know I have. For this reason, I decided to create a simple, no BS manual that you can easily reference and quickly come up with HIT running drills without the unnecessary scientific fuss; Something that is pragmatic as hell. The HIT drills in this manual will mostly be useful for coaches and sport scientists working in team sports (such as soccer, rugby or basketball), or individual sports that utilize running-based HIT conditioning (e.g. combat sports). Track & Field coaches (especially short and middle distance running coaches) may find some HIT variations interesting and I think the models explained here could be very useful in their coaching.

HIT stands for High Intensity Interval Training and, as with any other training construct, it is hard to precisely define. I want this manual to be more actionable and less precise, or to *satisfice*, as Herbert A. Simon, father of artificial intelligence, would call it (Christian & Griffiths, 2016; Phillips et al., 2017; Gigerenzer, 2004; 2008; 2014; Gigerenzer & Gaissmaier, 2011; Klein, 2017; Mousavi & Gigerenzer, 2014; Neth & Gigerenzer, 2015). In other words, I want the approach to HIT in this manual to be good enough to be easily applied in practical settings and understandable by coaches. Having said this, I consider all training intensities above velocity at lactate threshold (vLT) or velocity at gas exchange threshold (vGET) to be High Intensity Interval Training (Buchheit & Laursen, 2013b; 2013a; Poole & Jones, 2011).

I am pretty certain that some lab coats will complain and point to the facts that the numbers in this manual are not precise, or that the planning strategies outlined are not *optimal*. These are all fair critiques, but most lab coats reason from an *unbounded* position, where they try to find idealistic or optimal training (conditional on the model assumptions). It bears mentioning Yogi Berra's saying: "*In theory there is no difference between theory and practice. In practice there is.*" In real life, coaches are struggling with a lot of uncertainties (several of which will be covered in this manual): time pressures and constraints, equipment, and very weird and unpredictable complex beings called athletes. So finding the 'optimal' solution is most likely waste of time, or even worse, impossible. Hence, in practical and complex settings, such as real life coaching and training, it's futile to try to find the optimal solution, but rather to utilize a few simple *rules of thumb* (or *heuristics*) that help in finding the solutions that *satisfice* (Christian & Griffiths, 2016; Phillips et al., 2017; Gigerenzer, 2004; 2008; 2014; Gigerenzer & Gaissmaier, 2011; Klein, 2017; Mousavi & Gigerenzer, 2014; Neth & Gigerenzer, 2015). That is exactly my aim with this HIT Manual.

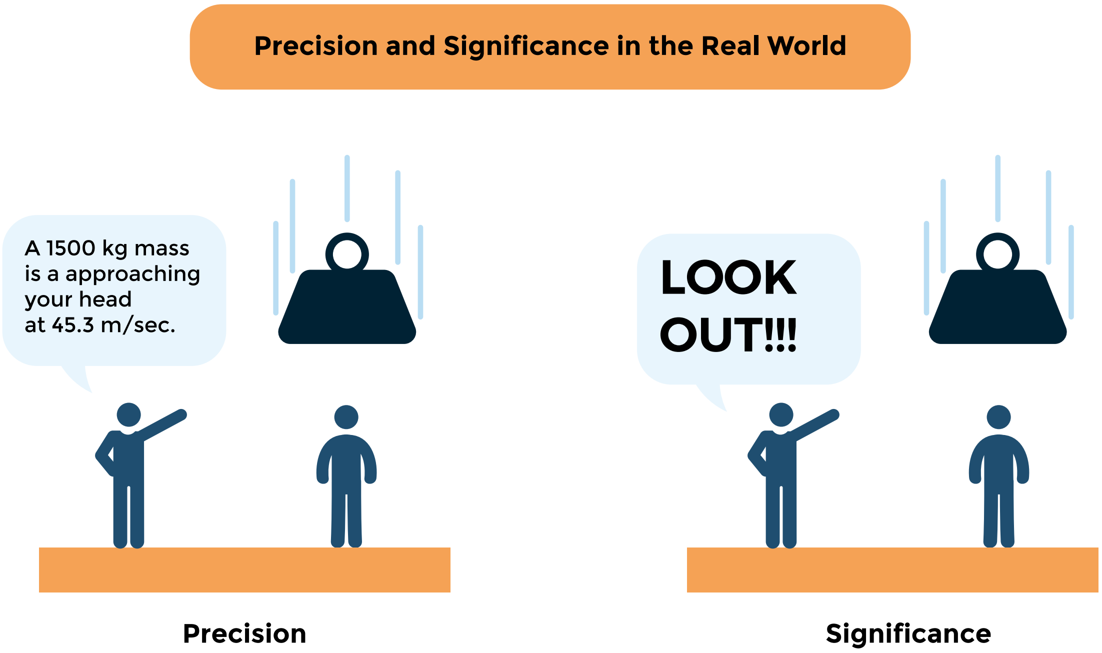


Figure 1. Difference between precision and significance. Image modified based on Fuzzy Logic Toolbox™ User's Guide, available at https://www.mathworks.com/help/pdf_doc/fuzzy/fuzzy.pdf

Overview of the HIT Manual

The HIT Manual is organized in two main sections: HIT basics and HIT planning. HIT basics covers the following major points:

- Understanding the "Endurance Map" and terminology
- Equipment that is needed to test and prescribe HIT conditioning
- Understanding the "Velocity Profile"

- Estimations of key HIT parameters, that are needed for prescription and profiling
- Prescription of the HIT conditioning, corrections using start loss and COD loss, as well as grouping of athletes
- Different HIT drills - long intervals, short intervals and tempo, sprint interval training, repeat sprint training, and intermittent recovery

The planning part of the HIT manual outlines the basis of **Agile Periodization**, which is a framework of approaching planning from an uncertainty perspective. HIT planning covers:

- Understanding uncertainties involved in training planning and realization
- Three levels and types of analysis: phenomenological, mechanistical, and physiological
- Answering "what should be done" and "when should it be done" using simple heuristics
- Top-up approach to planning HIT conditioning
- Understanding the above will empower you in selecting, designing and planning HIT conditioning for both individual and team sports. But before we jump into the material, it is important to have a big picture overview of the endurance methods and energy systems.

The "Endurance Map"

"The map is not the territory" - Alfred Korzybski

"All models are wrong, but some are useful" - George Box

The real world is very complex and uncertain. To help in orienting ourselves in it, we create maps and models. These are representations of reality, or representations of the real world. In the outstanding statistics book "Statistical Rethinking" (McElreath, 2016), Richard McElreath uses an analogy, originally coined by Leonard Savage (Savage, 1962), that differentiates between a ***Large World*** and ***Small World***:

*The **small world** is the self-contained, logical world of the model. Within the small world, all possibilities are nominated. There are no pure surprises, like the existence of a huge continent between Europe and Asia. Within the small world of the model, it is important to be able to verify the model's logic, making sure that it performs as expected under favorable assumptions. Bayesian models have some advantages in this regard, as they have reasonable claims to optimality: No alternative model could make better use of* *the information in the data and support better decisions, assuming the small world is an accurate description of the real world.*

*The **large world** is the broader context in which one deploys a model. In the large world, there may be events that were not imagined in the small world. Moreover, the model is always an incomplete representation of the large world and so will make mistakes, even if all kinds of events have been properly nominated. The logical consistency of a model in the small world is no guarantee that it will be optimal in the large world. But it is certainly a warm comfort.*

--- taken from "Statistical Rethinking", page 19 (McElreath, 2016)

Figure 2. Small World is a simplification of the complex Large World. It is important not to forget the distinction.

The key takeaway to keep in mind is not to confuse the two. The models presented in this HIT manual are the "small worlds," which we hope to deploy in the "large world." They are all wrong - the question is how useful they are. All physiological models as well as planning strategies are the 'small world' entities. The problem is that many coaches and lab coats confuse them for the 'large world.' In this HIT manual I will provide my rationale for using ***satisficing***, ***phenomenological*** and ***heuristics*** approaches for decision making in uncertainty (i.e. large world), while avoiding confusing the small world for reality.

One such model (or a map) is the "Endurance Map." I've created the Endurance Map for a rough outline of the common "endurance small worlds" (maps and models used in endurance circles). There are numerous things that are wrong in this model and even more assumptions behind it, but it is pretty good at giving the big picture overview of the endurance world. Yes, a lot of things depend on the particular individual and his characteristic, but the general overview still holds true.

Velocity (km/h)	% MSS	% ASR	Tlim (sec)	% MAS	HR (bpm)	% HRmax	% HRres	% VIFT	% vLT	% LTHR	bLA (mmol)	Thresholds	Intensity Zones	Domains	Endurance Methods	HIIT Methods	Energy System	Fibers	RPE
35	100%	100%	0 sec	194%				167%	233%			MSS	HIT	Extreme	Neuromuscular Power	RST	Alactic Phosphagen	Fast Twitch	10
34.5	99%	97%	2 sec	192%				164%	230%										
34	97%	94%	5 sec	189%				162%	227%										
33.5	96%	91%	7 sec	186%				160%	223%										
33	94%	88%	10 sec	183%				157%	220%										
32.5	93%	85%	12 sec	181%				155%	217%										
32	91%	82%	15 sec	178%				152%	213%										
31.5	90%	79%	18 sec	175%				150%	210%							SIT	Anaerobic Glycolitic		
31	89%	76%	21 sec	172%				148%	207%										
30.5	87%	74%	24 sec	169%				145%	203%										
30	86%	71%	27 sec	167%				143%	200%										
29.5	84%	68%	30 sec	164%				140%	197%			Wingate							
29	83%	65%	33 sec	161%				138%	193%										
28.5	81%	62%	37 sec	158%				136%	190%										
28	80%	59%	41 sec	156%				133%	187%										
27.5	79%	56%	45 sec	153%				131%	183%										
27	77%	53%	49 sec	150%				129%	180%										
26.5	76%	50%	53 sec	147%				126%	177%										
26	74%	47%	58 sec	144%				124%	173%							Tempo			
25.5	73%	44%	63 sec	142%				121%	170%										
25	71%	41%	68 sec	139%				119%	167%										
24.5	70%	38%	74 sec	136%				117%	163%										
24	69%	35%	80 sec	133%				114%	160%										
23.5	67%	32%	87 sec	131%				112%	157%										
23	66%	29%	94 sec	128%				110%	153%							Short Intervals			
22.5	64%	26%	102 sec	125%				107%	150%						Anaerobic Capacity				9
22	63%	24%	111 sec	122%				105%	147%										
21.5	61%	21%	122 sec	119%				102%	143%										
21	60%	18%	133 sec	117%				100%	140%			VIFT							
20.5	59%	15%	147 sec	114%				98%	137%										
20	57%	12%	165 sec	111%				95%	133%										
19.5	56%	9%	187 sec	108%				93%	130%										
19	54%	6%	218 sec	106%				90%	127%						VO2max Intervals	Long Intervals			8
18.5	53%	3%	271 sec	103%				88%	123%										
18	51%	0%	4-8min	100%	200	100%	100%	86%	120%	114%	>10 mmol	vVO2peak / MAS					Mixed Zone		
17.5	50%			97%	196	98%	97%	83%	117%	112%				Severe					
17	49%			94%	192	96%	94%	81%	113%	110%									
16.5	47%		15-20min	92%	188	94%	92%	79%	110%	107%	5-6 mmol	Critical Velocity							
16	46%			89%	183	92%	89%	76%	107%	105%				Heavy	Threshold				7
15.5	44%			86%	179	90%	86%	74%	103%	102%									
15	43%		40-60min	83%	175	88%	83%	71%	100%	100%	4 mmol	Anaerobic Threshold							
14.5	41%			81%	171	85%	81%	69%	97%	98%			MIT	Moderate		Active Recovery	Aerobic mitochondrial respiration	Slow Twitch	
14	40%			78%	167	83%	78%	67%	93%	95%					Sweet Spot				6
13.5	39%			75%	163	81%	75%	64%	90%	93%									
13	37%			72%	158	79%	72%	62%	87%	90%					Intensive Endurance				5
12.5	36%			69%	154	77%	69%	60%	83%	88%									
12	34%			67%	150	75%	67%	57%	80%	86%	2 mmol	Aerobic Threshold							
11.5	33%			64%	146	73%	64%	55%	77%	83%			LIT		Extensive Endurance				3
11	31%			61%	142	71%	61%	52%	73%	81%									
10.5	30%			58%	138	69%	58%	50%	70%	79%									
10	29%			56%	133	67%	56%	48%	67%	76%									
9.5	27%			53%	129	65%	53%	45%	63%	74%									
9	26%			50%	125	63%	50%	43%	60%	71%					Active Recovery		Aerobic Fat Burning		1
8.5	24%			47%	121	60%	47%	40%	57%	69%									
8	23%			44%	117	58%	44%	38%	53%	67%									
7.5	21%			42%	113	56%	42%	36%	50%	64%									
7	20%			39%	108	54%	39%	33%	47%	62%	1 mmol	Walking Threshold							

Figure 3. The "Endurance Map" – a very simplistic map of the endurance Large World.

The Endurance Map assumes flat surface continuous running. It represents a velocity continuum from **Maximum Sprinting Speed (MSS)** to zero, or in this case, the walking threshold (a velocity where one is unable to walk any faster and one needs to switch to running), which is around 7km/h (depending on the individual).

The major constructs used in the Endurance Map, as well as in this HIT manual, are **Maximum Sprinting Speed (MSS)** and **Maximum Aerobic Speed (MAS)**. Maximum Aerobic Speed is the minimal velocity associated with maximal oxygen uptake (VO2peak) during a graded exercise test (GXT). The velocity zone between MSS and MAS is usually termed **Anaerobic Speed Reserve (ASR)**. The concept of ASR will be explained in much more detail later in this manual.

Other important constructs in the endurance world (although not in this HIT manual) are **Critical Velocity (CV)**, **Anaerobic Threshold (AnT)**, and **Aerobic Threshold (AT)**. With these three it is very easy to enter the rabbit hole of physiological models, so I will keep it simple. If you are interested in more details, please see the references.

Critical Velocity (CV) is mathematically defined as the velocity-asymptote of the hyperbolic relationship between velocity and time-to-exhaustion (Clarke & Skiba, 2013; Poole & Jones, 2011; Vanhatalo, Jones, & Burnley, 2011). To estimate it, one needs at least 4 time trials of different durations (e.g. 2min to 20min). The idea is, at least in theory, that above CV, one will start utilizing their **anaerobic capacity** and work on borrowed time. Critical Velocity is somewhere right in the middle between MAS and Anaerobic Threshold (AnT). The duration of work at CV is around 15-20min (although in theory it is unlimited). There are numerous ways to establish critical velocity (Clarke & Skiba, 2013; Maturana, Fontana, Pogliaghi, Passfield, & Murias, 2017).

Anaerobic Threshold (AnT) is tricky to define. Lab coats fight about it all the time. Historically, it has been identified using the maximum lactate steady state (MLSS), a threshold of 4 mmol of lactate in the blood (vLT), using gas exchange threshold (vGET), or second ventilatory threshold (vVT2), among many others. It seems that one starts recruiting more fast twitch fibers as they pass the anaerobic threshold, which results in work on borrowed time (similar to Critical Velocity). The duration that can be run at anaerobic threshold is around 20-40minutes. In this manual, everything over anaerobic threshold is considered HIT.

Aerobic Threshold (AT) is even harder to define. It usually represents the initial rise in resting blood lactate levels during a graded exercise test (GXT), which is around 2mmol, or first ventilatory threshold (vVT1).

For the sake of completeness, I've included Martin Buchheit's **Intermittent Fitness Test velocity (VIFT)**, which is going to be covered extensively in the text, as well as a Wingate Test (or a 30sec sprint test).

When it comes to the endurance world, getting lost in the details is very easy. So for this very reason, I have created this small world representation that is helpful in getting the big picture. The above five constructs are used in defining other important constructs in the endurance world, but are also used to express speed (or intensity) in a relative way. In the Endurance Map, speed is expressed in absolute terms (i.e. km/h), but also as a percentage of important constructs - %MSS, %ASR, %MAS, %vLT, and %VIFT. Expressed as such, it makes it more generalizable across athletes.

Using heart rate (HR) is possible only for sub-MAS velocities. The Endurance Map assumes maximum heart rate (HRmax) to be 200 bpm and resting heart rate to be 50 bpm. For sub-MAS velocities, intensity can be also expressed as %HRmax, %HRres (heart rate reserve, which is the difference between HRmax and resting heart rate), or %LTHR (heart rate associated with lactate threshold). Using relative intensity, rather than beats per minute, makes this model more generalizable across athletes.

Using the above constructs and relative velocities and heart rates, it is easier to map the endurance territory for the sake of the big picture overview. Let's explore some of those regions.

Using aerobic and anaerobic thresholds, Seiler (Seiler & Tønnessen, 2009) and authors from Norwegian group (Solli, Tønnessen, & Sandbakk, 2017) differentiated between three intensity zones:

1. High Intensity Training (HIT)
2. Medium Intensity Training (MIT)
3. Low Intensity Training (LIT)

As alluded to already, everything over the velocity associated with lactate threshold (e.g. around 80% MAS) is considered HIT.

The separation into different intensity domains (Poole & Jones, 2011) is really helpful to distinguish what is steady state (see Figure 4). In the Moderate domain, once steady state is achieved (e.g. after 2 minutes), heart rate (HR) and oxygen consumption (VO_2) tend to stay stable. In the Heavy domain, which is between lactate threshold and critical velocity, heart rate and oxygen consumption show a ***drift***. In other words, they tend to increase over time, but will not reach maximal values.

In the Severe domain (which is over critical velocity, but less than MAS), not only will there be a drift, but HR and VO_2 will reach maximal values.

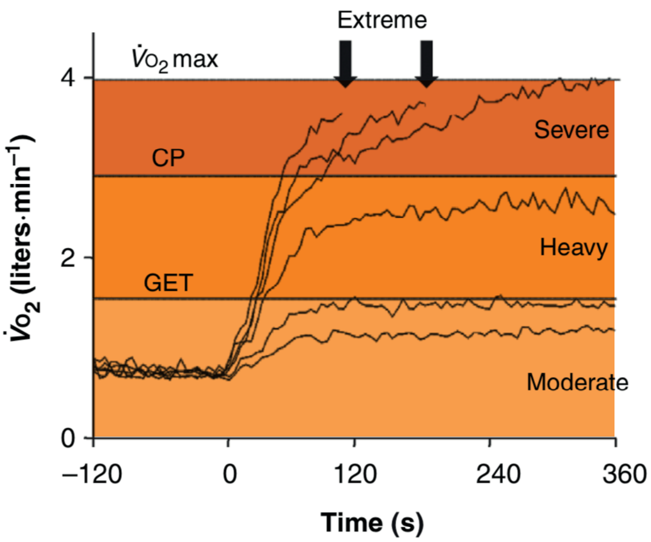


Figure 4. Poole & Jones model differentiating between four intensity zones. Taken from Poole, D. C., & Jones, A. M. (2011). Oxygen Uptake Kinetics (Vol. 72, pp. 1810–65).

The endurance methods column lists common endurance training methods that are based on %HRmax as well as %MAS and %vLT. Since this is a HIT manual, these are not going to be covered in detail. Interested readers are encouraged to check out Lyle McDonald's article series on Methods of Endurance Training (McDonald, 2009).

In the HIT method column, you will find the HIT methods (without visualizing overlap between them) that will be covered in much more detail later in the text.

The Energy System column oversimplifies the energy systems used (this is a huge rabbit hole for those interested). The Fibers column also represents an oversimplification of motor-unit recruitment. The RPE column oversimplifies rate-of-perceived effort at the beginning of the interval.

Overall, the Endurance Map is a gross oversimplification of the endurance world, but it is useful in making some sense and in orienting oneself. Besides, it provides a general idea of how things fit together.

Having this covered, the next thing to discuss is the needed tools for HIT conditioning.

Tools you will need

To apply the approach presented in this HIT Manual, you will need a few basic tools or pieces of equipment. Some will be easier to acquire while some will be more costly; for that reason I will provide a few alternatives. But by providing multiple alternatives, I run the risk of making this manual more complex and hence less understandable. I do want to make HIT prescription as simple as possible, but not so much so that it becomes too rigid. So, in a way, I had to ***satisfice*** and provide something that is precise enough, but also flexible enough for coaches in different situations to apply.

Cones

You will need a simple set of cones to set up the running tracks. Having them in multiple colors (or sizes) might be helpful in distinguishing different groups.

Figure 5. Cones

Stopwatch and whistle

Hopefully, as a coach, you already have a stopwatch and a whistle. If you don't, make sure to get them ASAP and make sure to get a stopwatch with a timer function. Having a timer function helps you time the intervals, especially the short intervals such as 15:15. Using a whistle, you can give 'beeps' to athletes or yell out the time left. For example, "to the cone in 3... 2... 1... stop!"

Figure 6. Stopwatch and whistle

Distance measuring wheel

Having a distance measuring wheel is a must. Since you will be estimating distances to be covered in a given time frame, you will be needing a tool that allows you to do that.

Figure 7. Distance measuring wheel.
You will need this tool to measure distances

Beeper

In the case where you do not want to look at your stopwatch and give 'beeps' using a whistle, you can use an outdoor timer with a loud beeper. It does need to be loud. It is also great for playing pranks on your fellow coaches when in the office.

Timing gates

With some HIT drills, to improve prescription precision (and hence individualize better), it is important to know athletes' **MSS** (Maximum Sprinting Speed). I will provide a few alternatives for assessing MSS, but ideally you would want to have proper timing gates.

Figure 8. Timing gates.
These are needed to proper estimation of Maximum Sprinting Speed

Shuttle Run Beep Test

The special version of the 20m Shuttle Run Beep Test (SRBT), that implements beep corrections for changes of direction (COD) can be downloaded at hitbuilder.net. This way, results from the 20m shuttle version beep test are in higher agreement with straight line beep tests (VamEval, Leger-Bucher or UMTT), while also being training-specific and sport-specific (Buchheit, 2010). You will use the velocity reached in this test as an estimate of **MAS** (Maximum Aerobic Speed).

To perform this test, you will need a loud stereo system and an MP3 player. Your smart phone or tablet connected to a speaker system will suffice. You will find the accompanying collecting sheet at the end of this manual.

I will also provide a few alternatives to this test, but stating this right upfront, Yo-Yo Intermittent tests are not good substitutes for shuttle-run beep test (SRBT) (Dupont et al., 2010; Heaney, Williams, Lorenzen, & Kemp, 2009).

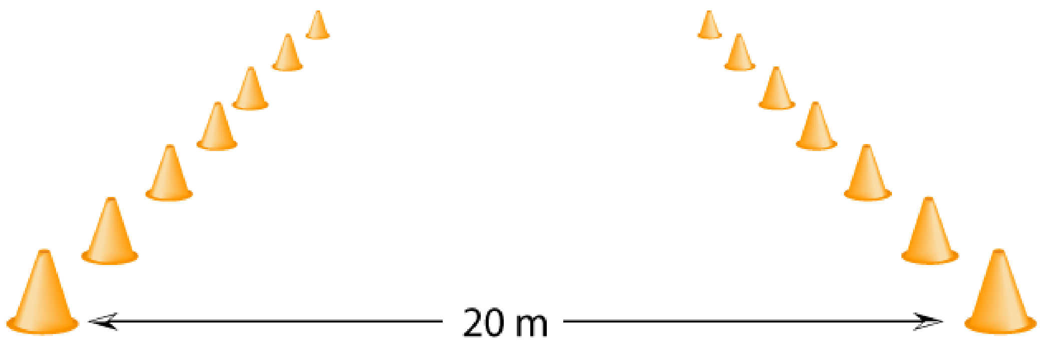


Figure 9. Shuttle Run Beep Test setup

Buchheit's 30:15 Intermittent Fitness Test (IFT)

Buchheit's IFT is a great alternative and/or addition to the shuttle-run beep test (SRBT), which also takes into account multiple other qualities (such as MSS, COD efficiency, intra-set recovery and so forth) that makes it an outstanding testing choice (Buchheit, 2010). Deciding between MSS, MAS and IFT for prescribing HIT drills is an important discussion that will soon be covered. If you wish to perform Buchheit's IFT, it can be downloaded here: https://3015ift.wordpress.com/2013/07/10/audio-files/

HIT Builder

HIT Builder is an accompanying spreadsheet that can be downloaded at hitbuilder.net. It allows for the creation of quick HIT drills for up to 200 athletes. The HIT Builder will be referenced on multiple occasions in this manual.

To wrap this up, the bare bones minimum of the tools you will need is the following:

1. Cone
2. Stopwatch and whistle
3. Distance measuring wheel
4. Shuttle Run Beep Test (and speaker system)

Velocity Profile

A Velocity Profile is a simple and neat way to visualize and understand relationships between crucial constructs (or qualities) that are used in prescribing HIT conditioning. Those constructs are **Maximum Aerobic Speed (MAS)** and **Maximum Sprinting Speed (MSS)**. There are other constructs involved such as Critical Velocity (CV), velocity at lactate threshold (vLT), velocity at gas exchange threshold (vGET), as well as velocity at first and second ventilatory thresholds (vVT1, vVT2). These thresholds (constructs) could be useful in depicting the full velocity profile and intensity domains (Poole & Jones, 2011; Seiler & Tønnessen, 2009), but are not needed in HIT prescription. For that reason they are excluded.

Let's assume that Athlete A has a MAS of 4.44 m/s (16 km/h) and a MSS of 9 m/s (32.4 km/h). Don't worry, I will explain what MAS and MSS mean and how they are estimated. The velocity profile of the Athlete A is depicted in the picture below:

The Velocity Profile is a simple table that lists velocities from zero to MSS (Maximum Sprinting Speed). MSS is the maximal velocity that a given athlete can achieve.

MAS stands for Maximum Aerobic Speed and, from a physiological standpoint, it represents the minimal velocity associated with VO_2peak on a GXT (Graded Exercise Test). From a practical standpoint, it represents the velocity (or pace) that athletes can maintain for 4-8 minutes, give or take. Lab coats can argue on these topics till the cows come home, but as coaches we need something precise enough to work from, something that is good enough to prescribe training, evaluate training effects and also cover our own assess when the head coach asks us what we have been doing.

There are multiple ways to estimate maximum aerobic speed (MAS) and there is no reason for sleepless nights over the correct, most precise, or optimal method to establish it.

The approach I am advocating for in this manual will use a shuttle-run beep test (SRBT) to establish maximum aerobic speed (MAS). Perfect? No. Usable? You bet.

Velocity	%MSS	%ASR	Tlim	Dist	%VIFT	%MAS	
9.00	100%	100%	0 sec	0 m	177%	203%	MSS
8.77	97%	95%	4 sec	35 m	173%	198%	
8.54	95%	90%	8 sec	69 m	168%	192%	
8.32	92%	85%	13 sec	104 m	164%	187%	
8.09	90%	80%	17 sec	139 m	159%	182%	
7.86	87%	75%	22 sec	174 m	155%	177%	
7.63	85%	70%	27 sec	209 m	150%	172%	
7.40	82%	65%	33 sec	245 m	146%	167%	
7.18	80%	60%	39 sec	282 m	141%	162%	
6.95	77%	55%	46 sec	320 m	137%	156%	
6.72	75%	50%	53 sec	358 m	132%	151%	
6.49	72%	45%	61 sec	399 m	128%	146%	
6.26	70%	40%	70 sec	442 m	123%	141%	
6.04	67%	35%	81 sec	487 m	119%	136%	
5.81	65%	30%	93 sec	538 m	114%	131%	
5.58	62%	25%	107 sec	595 m	110%	126%	
5.35	59%	20%	124 sec	663 m	105%	121%	
5.12	57%	15%	146 sec	748 m	101%	115%	VIFT
4.90	54%	10%	177 sec	867 m	96%	110%	
4.67	52%	5%	230 sec	1076 m	92%	105%	
4.44	49%	0%	4-8min		88%	100%	MAS
4.22	47%				83%	95%	
4.00	44%				79%	90%	
3.77	42%				74%	85%	
3.55	39%				70%	80%	
3.33	37%				66%	75%	
3.11	35%				61%	70%	
2.89	32%				57%	65%	
2.66	30%				53%	60%	
2.44	27%				48%	55%	
2.22	25%				44%	50%	
2.00	22%				39%	45%	
1.78	20%				35%	40%	
1.55	17%				31%	35%	
1.33	15%				26%	30%	
1.11	12%				22%	25%	
0.89	10%				18%	20%	
0.67	7%				13%	15%	
0.44	5%				9%	10%	
0.22	2%				4%	5%	
0	0%				0%	0%	

Figure 10. Example of Velocity Profile

The Velocity Profile revolves around MSS and MAS. The velocity zone between the two is called **ASR**, or **Anaerobic Speed Reserve** and it is an important concept for prescribing HIT drills.

Please don't bother with distinctions between aerobic and anaerobic in MAS and ASR. Just use the acronyms and look at them as good and precise-enough constructs that are useful for prescribing HIT conditioning, rather than figuring out the exact physiological rationale.

The very applied research by Matthew Bundle, Peter Weyand, **et al.** (Bundle, Hoyt, & Weyand, 2003; Bundle & Weyand, 2012; Weyand, 2005; Weyand & Bundle, 2005) confirmed that a certain % of ASR can be maintained for specific, limited time (Tlim on the table) **REGARDLESS** of MAS and MSS.

%ASR	Tlim (sec)
100%	0
95%	4
90%	8
85%	13
80%	17
75%	22
70%	27
65%	33
60%	39
55%	46
50%	53
45%	61
40%	70
35%	81
30%	93
25%	107
20%	124
15%	146
10%	177
5%	230

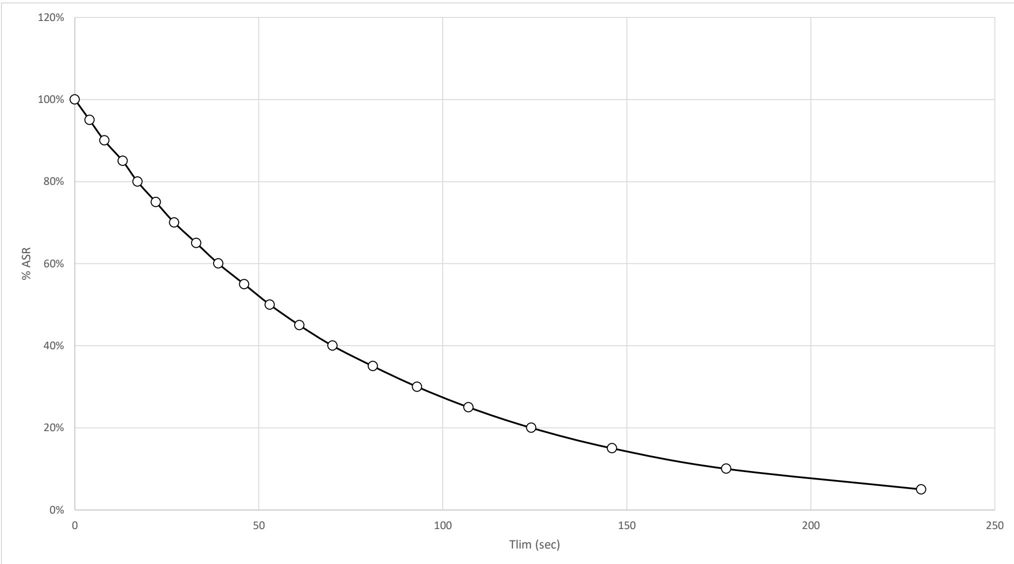


Figure 11. Relationship between %ASR and the time it can be maintained (Tlim)

This has multiple practical applications. First, if we know MAS and MSS we can predict, with a certain level of precision, performance over a specific distance. For example, our Athlete A with a MSS of 9 m/s (32.4 km/h) and a MAS of 4.44 m/s (16 km/h) can maintain 90% of his ASR velocity (8.54 m/s) for 8 seconds, during which he will cover about 70 meters. If we wish to predict his 100m (flying start) time, we can do that as well - it is 12 seconds and it represents 85% of his ASR.

Second, we know that with two time trials (e.g. 100m and 400m, utilizing a flying start), we can establish MAS and MSS. Let's assume Athlete B covers 100m in 12 seconds and 400m in 60 seconds. Using the above model, her MSS is estimated to be 8.94 m/s (32.2 km/h) and her MAS is 4.74 m/s (17.1 km/h). There are more nuances here of course, like **time loss** (when not using flying start), which needs to be taken into account, as explained later. The Matthew Bundle, Peter Weyand, **et al.** ASR model assumes **flying starts** and this needs to be taken into account for distances less than 150m when using standing or block start (Peter Weyand; personal communication), due to time loss on the start (more about this later).

Third, we might estimate MSS from a known MAS and one time trial (or vice versa - establish MAS from a known MSS and one time trial). Let's assume Athlete C has a MAS of 4 m/s (14.4 km/h), established using a shuttle-run beep test (SRBT), and runs 100m in 10.5 seconds (flying start). Her established MSS is 10.33 m/s (37.2 km/h).

Fourth, assuming that MSS and MAS are causal constructs/qualities that explain (and cause) HIT performance (let's not forget that they are actually estimated from performance itself), we can perform a **sensitivity** analysis. In plain English, for a given distance of interest (e.g. 300m) and for a given athlete, with his MAS and MSS values, we can check which variable improvement (either MAS or MSS) will yield more improvement in times for that distance. This can help to inform training interventions (i.e. focus more on improving MSS or MAS). This is quite usable for Track & Field coaches, especially for middle-distance runners.

	m/s	km/h
MSS	9.00	32.4
MAS	4.44	16.0
Start loss	1.00 sec	
	meters	seconds
Distance	300	43.45

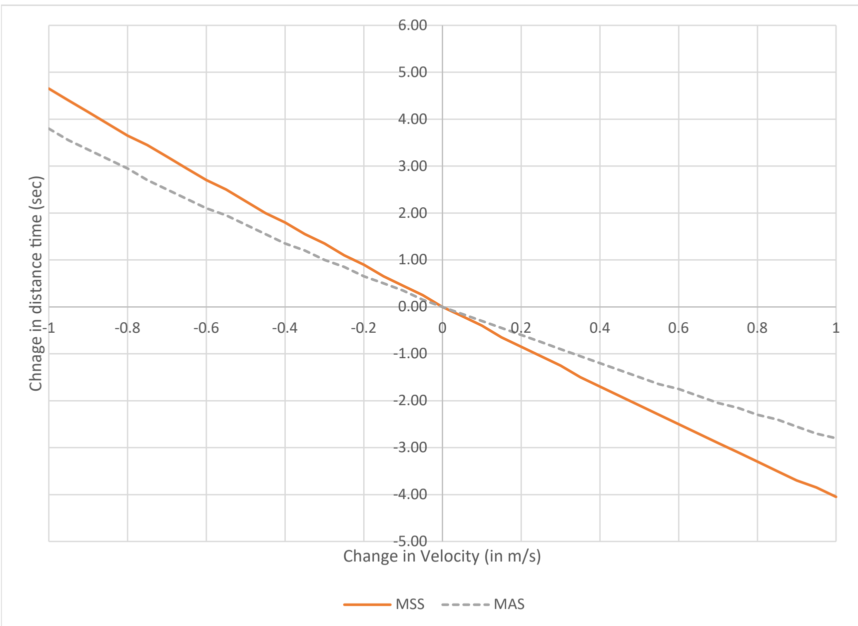


Figure 12. Sensitivity analysis

All of these functionalities are available in the accompanying HIT Builder. For those mathematically inclined, the above relationships are expressed as:

$$velocity = MAS + (MSS - MAS) * e^{-k*t}$$
$$\%ASR = e^{-k*t} * 100$$

Equation 1. Mathematical equations for relationship between time and velocity

For running, the coefficient k is equal to **0.013** and for cycling it is **0.026** (Bundle & Weyand, 2012; Weyand, 2005).

This model is very useful for velocities above maximal aerobic speed (MAS) and for all-out sprints of less than 150 seconds in duration. Which brings me to one important aspect: the need to use multiple models, since none of the performance models can be useful (and predictable) across the whole Velocity Profile. For example, knowing an individual's vGET (velocity at gas exchange threshold), or second ventilatory threshold (vVT2) as well as velocity at first ventilatory threshold (vVT1) is very helpful in predicting performance and prescribing training for time durations over 20 minutes, or in other words, for long distance runners (Seiler & Tønnessen, 2009). But, since this is a HIT Manual (i.e. for training at intensities over vGET or vLT2) I won't be expanding on these topics, but I urge interested readers to check **Daniel's Running Formula** (Daniels, 2013) for a more physiological approach to endurance training, or **The Science of Running** (Magness, 2013) for a critique of the physiological zones approach (and overall the best endurance running book). For the sake of completeness of the Velocity Profile, velocity at gas exchange threshold (vGET) is around 80% of MAS or 90% of HRmax, but this can vary from individual to individual.

Everything we need to know to prescribe HIT are MAS and MSS. One can solely use MAS, and MAS is good enough for prescribing HIT from about 90% to 105-110% MAS. However, for HIT above 105-110% MAS, it is better to use ASR (Anaerobic Speed Reserve). Buchheit's intermittent fitness test (IFT), where the velocities reached are around 1.15 to 1.20 times bigger than MAS (e.g. someone with 4 m/s MAS will most likely reach 4.6 m/s in IFT), is great for prescribing 105-120% MAS (or 85-105% IFT) HIT conditioning (Buchheit & Laursen, 2013a; 2013b). In plain English, although a great alternative and very usable for prescribing short intervals (less than 1min in duration), IFT is not enough for the full-scale of HIT prescriptions. If you plan on doing solely short intervals, then it is an absolutely great choice that can replace using MAS and MSS completely, but if you plan on prescribing long intervals (>1min) or very high intensity runs (>130-140% MAS), then you will need MAS and MSS estimates. Either way, I will provide the %IFT associated with different HIT drills in the case that you opt for that approach.

What about heart rate you might ask? Completely useless in HIT prescription (Buchheit & Laursen, 2013a; 2013b). What about using heart rate recovery to prescribe the start of the next interval (e.g. wait until HR drops to 130bpm or 60% HRmax)? Useless as well (Buchheit & Laursen, 2013a; 2013b), especially when working with large groups. Like I am going to let 30 soccer athletes decide when to start the next interval. In your dreams buddy.

Testing

To prescribe HIT conditioning using the approach outlined in this manual, you will need estimated MSS and MAS (or IFT). There are of course multiple approaches to do that and I will cover a few alternatives. Let's start with MAS, since having MAS without MSS will still allow you plenty of HIT prescription options.

Estimating Maximum Aerobic Speed (MAS)

As mentioned before, MAS is the minimal velocity associated with VO_2peak in GXT (graded exercise testing). There are, of course, nuances and arguments between the lab coats regarding the best way to establish MAS, from stage durations to increments in velocity during GXT (Pettitt, Clark, Ebner, Sedgeman, & Murray, 2013). I won't bother you with that. So, do you need laboratory test? Absolutely not.

There are multiple field options you can use and I highly recommend using the 20m Shuttle Run Beep Test (SRBT) that can be downloaded at hitbuilder.net. This test is performed between 20m cones until exhaustion. Velocity starts at 10km/h and it is increased by 0.5km/h every minute. The difference between this version of a beep test and the original beep test is in COD (change of direction) correction. Let's assume that an athlete performs straight-ahead beep tests, such as UMTT or VamEval, which are executed on a 200-400m track with cones set every 20m and with a velocity increase of 0.5km/h every minute. An athlete reaches the 16km/h stage. Now, imagine that the same athlete does this same test in shuttle fashion, where he/she needs to start, stop, and change direction. Will he/she reach same 16km/h stage?

The problem with the original shuttle run beep test is that it doesn't correct for time loss on COD, so MAS estimated using that test will be an underestimating true MAS

(Buchheit, 2010) and if you use that MAS for straight ahead HIT conditioning it will underestimate the velocities needed.

The SRBT uses COD corrections by adding 0.7s per turn. Perfect? No. Satisficing? Definitely. This way the SRBT estimates of MAS can be used for prescribing HIT conditioning for both straight line and shuttle-based conditioning.

To perform this test you will need 20m lanes for every athlete, a MP3 file and a speaker system, as well as the collecting sheet (that can be found at the end of this manual). Athletes can perform a standardized warm-up and then perform the test. The audio track will state the velocity at the beginning of each stage. For the sake of simplicity, write down the latest stage velocity that athlete was able to pass. It is a standard practice to provide three warning signs in a row before an athlete is considered out from the test, but you can modify this. Just make sure you are following the protocol you defined every time you perform the test.

Alternatives

Alternatives to the SRBT might include a time trial of 5 to 6 minutes or 1200-2000m (depending on the level of the athletes), where MAS is the average velocity (MAS = distance covered / time in seconds) (Baker, 2011). But in my experience, team sport athletes struggle with finding the right pace for these tests. If you have a training group that is experienced with longer time trials then be my guest and use this approach.

Another alternative is to use Buchheit's 30-15IFT and then **assume** MAS is IFT/1.2 (i.e. if IFT is 5m/s then MAS is 5 / 1.2, or 4.16 m/s). Again, this is not perfect, but it is good enough to get a MAS estimate.

You can also utilize straight ahead tests such as UMTT or VamEval. In my experience working with team sport athletes, it would be head coaches and even athletes who complain that this test is not sport-specific. The problem is not if the test is sport-specific, but rather what you plan using that test for. If you plan on performing a lot of straight-ahead HIT conditioning and prescribe intensities using MAS from a straight-ahead beep test, then it is a perfect, **training-specific** test and hence very usable.

The SRBT test is not as sport-specific as other tests such as the IFT or Yo-Yo because it doesn't have a break between the shuttles or stages. But for the HIT training that it is aimed for, it is very training-specific.

There is a trade-off between making a test more sport-specific and making a test more prescriptive (using the test to prescribe training) (Mendez-Villanueva & Buchheit, 2013). For example, one might design an incremental, intermittent soccer dribbling test, which would be very soccer-specific, but due to a lot of 'qualities' involved in this test, one would be uncertain if the test score is due a higher MAS, better COD, better dribbling technique, faster between-shuttles recovery, or you name it. It then becomes too complex for HIT conditioning prescription (unless your HIT drills involve dribbling the ball all the time). In a way, there needs to be a balance between the sport-specificity of the test and the complexity introduced. I find that balance in SRBT and IFT tests.

What about Yo-Yo tests? Can you use the velocity reached in Yo-Yo tests to estimate MAS and then prescribe HIT conditioning? No, you can't (Dupont et al., 2010; Heaney et al., 2009). The problem with the Yo-Yo is that the work:rest ratio changes as the velocity increases and that makes its connection to MAS more complex. The Yo-Yo tests are great, sport-specific tests, but they are not useful if you plan on using the velocity reached in these tests to prescribe HIT conditioning (hence low **prescriptiveness** (Mendez-Villanueva & Buchheit, 2013)). But, what if you plug in distance or speed reached in a Yo-Yo in some regression formula to get MAS? According to research (Dupont et al., 2010; Heaney et al., 2009), there is too big of an estimation error for the MAS established in that way to be useful. So ditch the Yo-Yo tests for that reason (for prescribing HIT conditioning).

If you still plan on doing a laboratory GXT, then stick to a similar velocity progression and stage duration and around a 1% treadmill incline (Pettitt et al., 2013).

Estimating Maximum Sprinting Speed (MSS)

Estimating MSS is a bit trickier because it demands timing gates. The protocol involves setting up the timing gates at a 5-10m distance and allowing for a 30-60m flying start (Bundle et al., 2003). It is up to the athletes to decide on the run-up distance as long as they reach their best 5-10m split time. The number of trials is around 5-7, with athletes allowed to take as much rest as they need (Bundle et al., 2003).

Figure 13. Timing gates setup for estimating maximum sprinting speed

As with other tests, the key is to stick to the same protocol when one repeats the test. Another approach might be to use a radar-gun, which also provides the full acceleration/speed profile, in addition to MSS (Buchheit et al., 2014). Having this acceleration/speed profile might be very useful in prescribing speed workouts and estimating training effects (Morin & Samozino, 2016)

Alternatives

What would be an alternative to estimating MSS? One alternative would be to use a flying 40m time and a known MAS and plug them into the ASR formula (Bundle et al., 2003). Let's say that our Athlete D has a MAS of 4.5 m/s and runs a flying 40m time of 4.8 seconds. When we plug this into HIT Builder, we get the following:

Start loss	**0.00**	sec
Long Sprint Distance	**40**	m
Long Sprint Time	**4.8**	sec
Average Velocity	8.33	m/sec
MAS	**4.50**	m/sec
	m/s	**km/h**
MSS	**8.58**	**30.9**
MAS	**4.50**	**16.2**

Figure 14. Alternative way to estimate MSS from known MAS and time over distance (flying start)

We calculated 8.58 m/s as this athlete's MSS. There is, of course, prediction error around this estimate due to uncertainties of the model itself and measurement error, but the result could be good enough to help in prescribing HIT conditioning.

Please note that the ASR model assumes flying starts and if standing or block starts are to be used one needs to adjust the **start loss** correction factor. Coaches Christopher Glaeser and Ken Jakalski suggest using 1.17 seconds to convert a block sprint to a fly sprint (Glaeser, 2018).

Let's see how this model predicts when we use 0.5s and a 1s correction:

Start loss	0.50 sec	
Long Sprint Distance	40 m	
Long Sprint Time	4.8 sec	
Average Velocity	9.30 m/sec	
MAS	4.50 m/sec	
	m/s	km/h
MSS	9.58	34.5
MAS	4.50	16.2

Start loss	1.00 sec	
Long Sprint Distance	40 m	
Long Sprint Time	4.8 sec	
Average Velocity	10.53 m/sec	
MAS	4.50 m/sec	
	m/s	km/h
MSS	10.83	39.0
MAS	4.50	16.2

Figure 15. Estimating MSS from known MAS and time over distance (standing start) depends a lot on start loss correction factor.

There probably could be a PhD thesis in researching agreement between an established MSS from flying and standing 40m sprints by using start loss correction and taking into account measurement errors as well as model prediction errors. We need something that is good enough (i.e. satisficing), so we can stick to using 1-1.5 second as a start loss correction factor. We can leave these prediction problems to the lab coats and sprint fanatics.

Either way, having MAS is more important than having MSS, since we can still prescribe a lot of HIT conditioning drills (from 90-110% MAS). But as I will shortly demonstrate, it is very useful to utilize ASR to individualize training prescription.

Reliability of the tests

Without going into measurement theory and statistics, it is always good to repeat any testing we perform on multiple occasions under the same conditions to estimate the typical error of the test. Knowing the typical error of the test is important when judging individual changes over time because it gives you some idea whether the change is real or a measurement fluke (or normal biological variation) (Hopkins, 2000; McGuigan, 2017). I always recommend doing **in-house** research on the beloved tests and use that in estimating reliability, rather than relying on published research (although that is definitely a great starting point, especially if you are deciding between multiple, similar tests). Since covering this topic is beyond this manual, I suggest checking (Hopkins, 2000; McGuigan, 2017) for more details on estimating reliability of the tests using typical error and its use in judging individual changes.

What to do after a training iteration

Do you need to re-test after every training iteration (or should I say phase or block)? Ideally yes, but testing should be as **embedded** inside the training practice as much as possible. For example, the use of timing gates should be frequent when you perform speed work. If you are training maximal velocity, you can use the numbers from training to update MSS if needed (without an explicit testing session that no one enjoys). When it comes to MAS, you can perform SRBT instead of HIT conditioning during the training session, rather than having a designated testing day. Even easier, after a successful training iteration in which the athletes fulfilled all HIT sessions without noticeable struggle, you can increase the MAS of each athlete by 0.25-0.5km/h, or around 0.07-0.14 m/s. I would still suggest an occasional test, but in case you lack the time to do it, you could use this simple increment.

With novel technologies such as GPS devices and better statistical techniques, one can estimate MSS and MAS from the training sessions themselves, assuming that the athletes gave maximal effort for a given time frame (e.g. 2 seconds for MSS or 5-6min for MAS). In the worst case, these estimates can give you some evidence whether or not to increase MAS for the next phase. But this is a topic for another manual.

HIT Prescription

You know your athletes' MAS and MSS, now what? We are going to use those numbers to estimate a velocity that each individual needs to run at for a given period of time (Baker, 2011). Depending on the type of HIT drill, different combinations of work intensity and duration, as well as recovery intensity and duration are prescribed. These various combinations will be covered later in the manual. Before that, it is important to know what to do with the estimated velocity.

Using MAS

Let's assume that a HIT drill calls for a 15sec run at 120% MAS with 15sec of passive rest in between. Our Athlete A has a MAS of 4.44 m/s (16 km/h), so the velocity he or she needs to run at is:

Velocity = Individual_MAS x %MAS

Velocity = 4.44 x 1.2

Velocity = 5.32 m/s

Now that we have velocity of the run, we need to calculate the distance that needs to be covered, which is equal to:

Distance = Velocity x Time

Distance = 5.32 x 15

Distance = 80m

So our Athlete A, with a MAS of 4.44 m/s (16 km/h), needs to run 80m for 15 seconds, which is equal to his 120% MAS velocity.

Here is the example for athletes with different MAS values when a 15sec straight line HIT drill is prescribed at 120% of MAS.

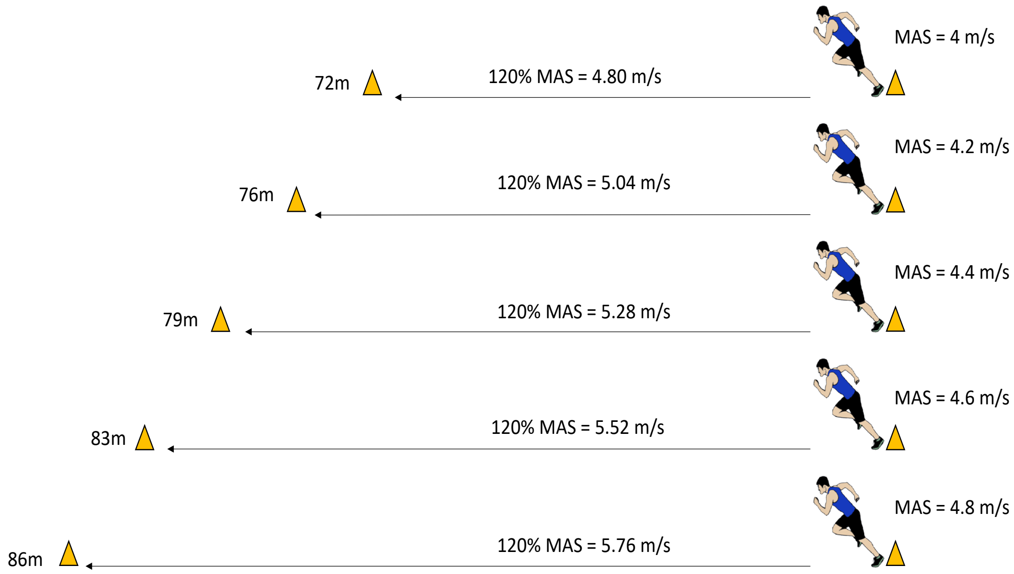


Figure 16. Estimated distances for 15sec run at 120% MAS for five athlete with different MAS values

Using IFT

When a given HIT drill calls for %IFT, the calculation is the same as the calculation for MAS. For the sake of example, let's assume our Athlete A has an IFT of 5.62 m/s (which is around 115-120% MAS). If the HIT drill calls for a 30sec straight line run at 100% IFT, the velocity and distance is equal to:

Velocity = Individual_IFT x %IFT

Velocity = 5.62 x 1.0

Velocity = 5.62 m/s

Distance = Velocity x Time

Distance = 5.62 x 30

Distance = 168m

Using ASR

Using ASR is a bit more involved compared to MAS and IFT because you will need to utilize both MAS and MSS. Let's assume that a HIT drill calls for a 10 second straight ahead run at 40% ASR. Out Athlete A has a MAS of 4.44 m/s and a MSS of 9 m/s, and his ASR is MSS - MAS, or 4.56 m/s. What is the velocity he needs to run at?

Velocity = MAS + (MSS – MAS) x %ASR

Velocity = 4.44 + (9 – 4.44) x 0.4

Velocity = 4.44 + 4.56 x 0.4

Velocity = 4.44 + 1.82

Velocity = 6.26 m/s

Once we have the velocity, it is easy to calculate the distance that needs to be covered in 10 seconds:

Distance = Velocity x Time

Distance = 6.26 x 10

Distance = 63 m

With the distance, it is enough to round to the closest meter. It bears repeating that the ASR approach assumes a flying start rather than a standing or block start. The above 63 meters in 10 seconds assumes the flying start. For this reason, one needs to use a start loss correction (as mentioned before, 1-1.5 seconds can be used to convert flying to a standing start, although this depends on the distance). Peter Weyand suggests using a correction for distances of less than 150m ***(personal communication)***.

Adjusting for start loss

One use of the start loss correction is to convert a flying start to a standing start (using 1-1.5 seconds correction) when using the ASR model. But start loss correction can be used in other scenarios. For example, imagine the above straight line 10sec run at 40% ASR is done on a track versus on a muddy field. Will the same effort be needed to cover the same distance in the same time in these two conditions? It would be much easier to do it on the track, of course. This is because on the muddy field it might take more time to accelerate to a given velocity (at the same effort level).

So we need a way to adjust for these differences. One could add extra time to the ***start loss*** variable, which we are already using to convert a flying start to a standing start when using the ASR model.

To be honest, this is more of an art than a science, and I would recommend using 0 to 2 seconds adjustment (on top of 1-1.5 standing start adjustment when using the ASR prescription approach), depending on the field type, velocity of the run, and distance/time.

We have already calculated velocity for the flying 10sec straight line run at 40 %ASR for Athlete A (MAS of 4.44 m/s and MSS of 9 m/s), so let's adjust the distance (which was 63 meters) assuming that on the mud the athlete loses 1sec during the standing start, on top of 1 second for the flying to standing start loss correction (total 1 + 1 = 2 seconds):

Distance = Velocity x (Time – Start Loss)

Distance = 6.26 x (10 - 2)

Distance = 6.26 x 8

Distance = 50 m

Assuming the start loss is 1 second on the mud (and a flying to standing correction of 1 second), the corrected distance is 50m, as opposed to 63m on the track when doing a flying start. It bears repeating that this is more an art than a science, so the suggested start loss corrections (on top of the flying to standing 1-1.5seconds when using the ASR method of HIT prescription) in the table below should be used with great caution.

Surface	Start Loss
Track (blocks)	0 - 0.25 seconds
Track (standing)	0 - 0.5 seconds
Grass	0.25 - 1 seconds
Mud	> 1 seconds

Table 1. Start loss correction for different field types. When using ASR to prescribe, these corrections are added on top of 1-1.5 sec correction for standing start. For example, start loss for standing start in mud is >2sec (1sec + 1sec)

If one uses MAS to prescribe HIT conditioning, then using the above start loss corrections are more than enough, but if you plan on using the ASR to prescribe, you will also need to use a flying to standing start loss correction (1-1.5 seconds) as demonstrated in the previous example. This also depends on the MAS test location

- if your athletes performed a shuttle run beep test (SRBT) on grass, then there is no need to correct for start loss when performing HIT conditioning on grass. I hope that you can already notice uncertainties in prescription, which deem approaching the issues in a more artistic form than a scientific or exact form. These uncertainties will propagate and will influence planning strategies as will be explained later in the manual.

Adjusting for COD (or HIT in shuttles)

Let's get back to our example of doing a 15 second interval at 120% MAS for Athlete A (MAS 4.44 m/s and MSS 9 m/s). We have estimated the run velocity to be 5.32 m/s (1.2 x 4.44) and distance to be 80 meters (5.32 m/s x 15 sec).

Suppose this athlete is a handball athlete and he cannot find an 80m indoor track to do this HIT drill. So you decide to run this 80m in shuttles: 2x40m. Will the needed effort be the same between the straight line and shuttle version? No, because of the time loss on COD (change of direction); this also needs to be taken into account.

The usual COD time loss is 0.7 seconds per 180 degree turn (Buchheit, 2008). This is a 'quick and dirty' heuristic that can be applied. But similar to start loss, this depends on surface, bodyweight (heavier lads need more time), velocity, shoes, angle of the turn, and of course the technical skill of the athlete.

Also keep in mind that the 20m Shuttle Run Beep Test (SRBT) used a 0.7 second time correction per turn, so if you are working with heavier blokes (e.g. rugby or American football athletes) that are tested on grass, make sure to use a version with 1.2sec correction that is available on the hitbuilder.net. You won't make a huge mistake if you go with the accompanying 0.7sec version of the SRBT, but MAS might be underestimated for bigger guys, which can be tricky if you plan on doing straight line HIT drills.

Let us now correct the distance of 80m for Athlete A, who plans to run this in a shuttle (2x40m, or two shuttles and one COD that needs a 0.7 second correction) at 5.32 m/s:

Distance = Velocity x (Time – (Shuttles – 1) x COD_Loss)) / Shuttles

Distance = 5.32 x (15 – (2 – 1) x 0.7)) / 2

Distance = 5.32 x (15 – 1 x 0.7)) / 2

Distance = 5.32 x (15 – 0.7)) / 2

Distance = 5.32 x 14.3 / 2

Distance = 38m

Assuming 0.7 seconds loss per COD, Athlete A needs to do 2x38m in 15 seconds to run at 120% of his MAS, or 5.32 m/s.

On the following table I have presented very quick and dirty COD time losses that you can use and experiment with. Same as with start loss, use these with extreme caution.

Surface	COD Loss
Track	0.5 - 0.7 seconds
Grass	0.7 - 1 seconds
Mud	1 - 1.5 seconds

Bodyweight	COD Loss
<60kg	0.5 seconds
60-80kg	0.7 seconds
80-100kg	1 second
>100kg	> 1 second

Table 2. Adjusting for change of directions (CODs) when performing HIT running drills in shuttles

Combining start loss and COD loss

To make your life really miserable, you can combine both start loss and COD loss. Let's assume that the above, 15 second shuttle run was done on muddy terrain, so we will use 1 second for a start loss (no need to correct for flying to standing since we are using MAS) and 1 second for COD loss to estimate the shuttle distance for Athlete A (120% MAS, MAS 4.44 m/s, MSS 9 m/s) whose running velocity is 5.32 m/s:

Distance = Velocity x (Time – Start_Loss – (Shuttles – 1) x COD_Loss)) / Shuttles

Distance = 5.32 x (15 – 1 – (2 – 1) x 1)) / 2

Distance = 5.32 x (15 – 1 – 1)) / 2

Distance = 5.32 x (15 – 2)) / 2

Distance = 5.32 x 13 / 2

Distance = 35m

No need to be scared of these formulas since they are all implemented in HIT Builder, which does this for you and much more. The important thing to keep in mind is prescription uncertainty - even if they are general rules, the exact prescription depends on multiple factors and it is probably an exercise in futility to be very precise (and scientific) in prescription. One should rather acknowledge that this is more of an art than a science and use the above computations as educated guesses, rather than something exact and precise (and fall for the ***scientism***, as explained later).

What about the recovery interval?

Some HIT drills call for an active recovery interval, usually at 50-70% MAS. Similar to the above, the velocities and distance covered during recovery can easily be calculated.

But there is a neat heuristic, especially if you perform drills in shuttles. Let's assume that the above HIT drill for Athlete A is done as 2x35 meters in 15 seconds with 15 seconds active recovery. The simple heuristic is to cover 1x35 in those 15 sec recovery. This works for intervals of 90-130% MAS with a recovery intensity somewhere in the range of 50-70% MAS.

If you want to be more precise, you can use the above calculations or let the HIT Builder do it for you. I like simple heuristics, so I prefer to do half the distance in the recovery (assuming work to rest is 1:1).

Prescribing using distance rather than time

I prefer to use time for prescribing HIT drills (the reason will be covered in the next chapter), but sometimes coaches use distance, which is also fine. But, if you are dealing with a large group, they will be completely out of sync and each athlete will need a beeper (since they have different times).

Anyway, this can work with individual athletes. For a given velocity and known distance (e.g. 5.32 m/s for Athlete A, and total distance of 100m, which is covered as 2x50m, with a start loss of 1 sec and COD loss of 1 sec), the time needed is calculated as follows:

Time = (Total Distance / Velocity) + Start_Loss + (Shuttles – 1) x COD_Loss

Time = (100 / 5.32) + 1 + (2–1) x 1

Time = 18.79 + 1 + 1

Time = 20.79

In this case our athlete will need to cover 2x50m in 21 seconds and the COD beep will happen at 21 / 2, or 10.5 seconds. So he has 10.5 seconds to cover 50m, and 10.5 seconds to cover another 50m (in 2x50m shuttles). These calculations can be performed automatically in HIT Builder.

Grouping Athletes

With the proposed method of HIT prescription in this manual, each athlete will have a specified distance that needs to be covered in a given HIT variation. If you have more than 3 athletes, you will probably want to place them into groups of similar distance, as shown below:

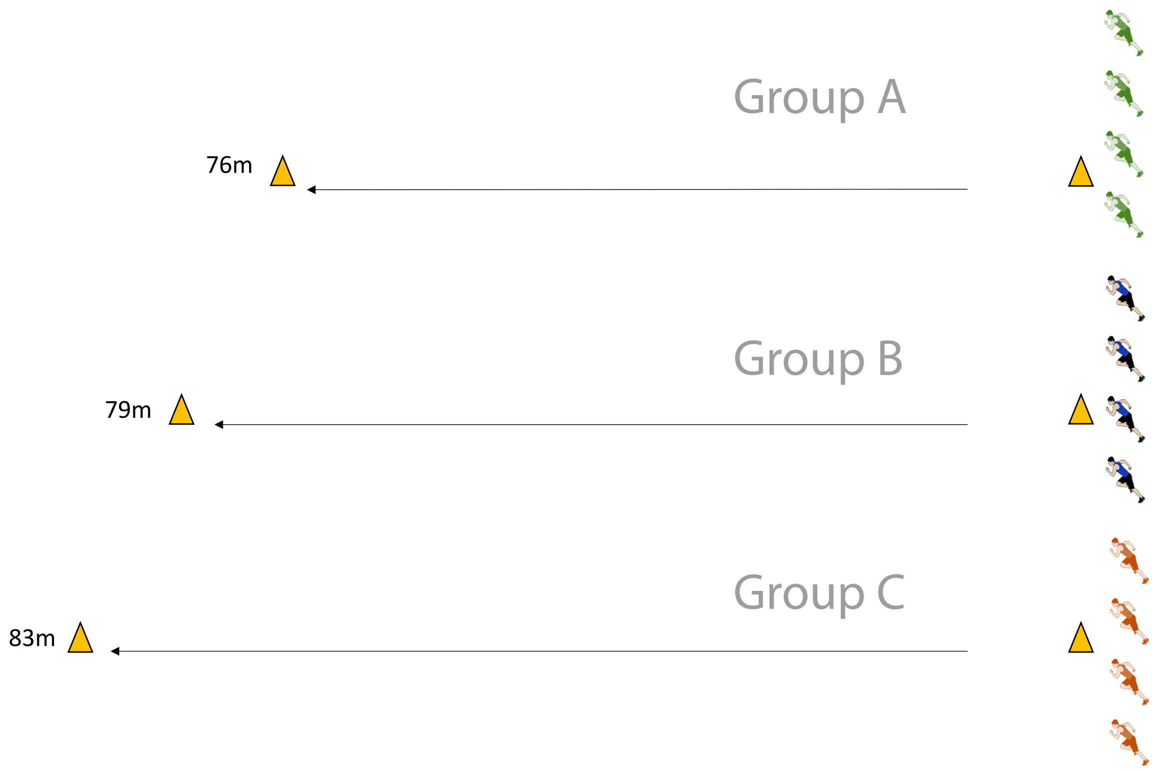


Figure 17. Grouping athletes with similar running distance

In an ideal world, you would assign a distance for each athlete, but in the real world ("Earth calling lab coats! Earth calling lab coats! Please respond!"), especially if you coach big teams, you will need to find groups of similar distance. But this is easier said than done, since we will not have easily identifiable clusters (or groups) of athletes.

The general rule of thumb (heuristic) would be that the difference between group assigned distance and individual distance is no bigger than 2.5 - 7.5%. The goal is to minimize the number of groups without breaking the above constraint.

Sound difficult? Actually it is not, and it would be easy to calculate the number of groups using best and worst distances and allow for individual difference (2.5% to 7.5%). Luckily for us, this is already implemented in the HIT Builder. You just need to write in the allowed individual difference and the HIT Builder distributes the athletes to groups and gives you the distance per group. Voila!

HIT Parameters	
HIT Category	**Ext Active Short Intervals (E-ASI)**
Variation	**20:10**
Prescribe using	**IFT**
Start loss (sec)	**0**
COD loss (sec)	**1**
Shuttles #	**1**
Show	**Min**

Progressions/Regression	
Work Intensity	**0**
Work Duration	**0**

Work Interval	
Duration	20
MAS	90
IFT	75
ASR	

Rest Interval	
Duration	10
MAS	50
IFT	40

Format	4-8min
# of Sets	2-6sets
Rest btwn sets	3-5min

Max diff allowed	**8%**
Max diff	5%
Groups	4

Group	Distance
1	92
2	83
3	76
4	67

			Athlete Info				
#	**Group**	**Athlete**	**MSS**	**MAS**	**IFT**	**Velocity**	**Distance**
19	1	Athlete 19	10.26	5.28	6.34	4.75	**95**
6		Athlete 6	10.11	5.24			
16	1	Athlete 16	10.10	5.24	6.29	4.72	**94**
13	1	Athlete 13	10.08	4.95	5.94	4.46	**89**
17	1	Athlete 17	9.55	4.90	5.88	4.41	**88**
12	2	Athlete 12	10.86	4.73	5.68	4.26	**85**
11	2	Athlete 11	10.93	4.55	5.46	4.1	**82**
9	2	Athlete 9	9.98	4.48	5.38	4.03	**81**
3	2	Athlete 3	9.09	4.64	5.57	4.18	**84**
1	2	Athlete 1	9.00	4.44	5.62	4.21	**84**
15	2	Athlete 15	9.08	4.48	5.38	4.03	**81**
7	2	Athlete 7		4.79	5.75	4.31	**86**
10	3	Athlete 10	10.67	4.22	5.06	3.8	**76**
5	4	Athlete 5	10.94	3.83	4.60	3.45	**69**
4	4	Athlete 4	10.54	3.70	4.44	3.33	**67**
8	4	Athlete 8	10.60	3.58	4.30	3.22	**64**
20	4	Athlete 20	10.31	3.60	4.27	3.2	**64**
2	4	Athlete 2	10.00	3.75	4.50	3.38	**68**
18	4	Athlete 18	9.61	3.97	4.76	3.57	**71**
14	4	Athlete 14	9.56	3.82	4.58	3.44	**69**
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							

Figure 18. Creating groups of athletes with similar running distance in HIT Builder

Setting up the lanes

It is quite common for coaches to setup HIT conditioning lanes side by side, with athletes starting from the same position (Baker, 2011):

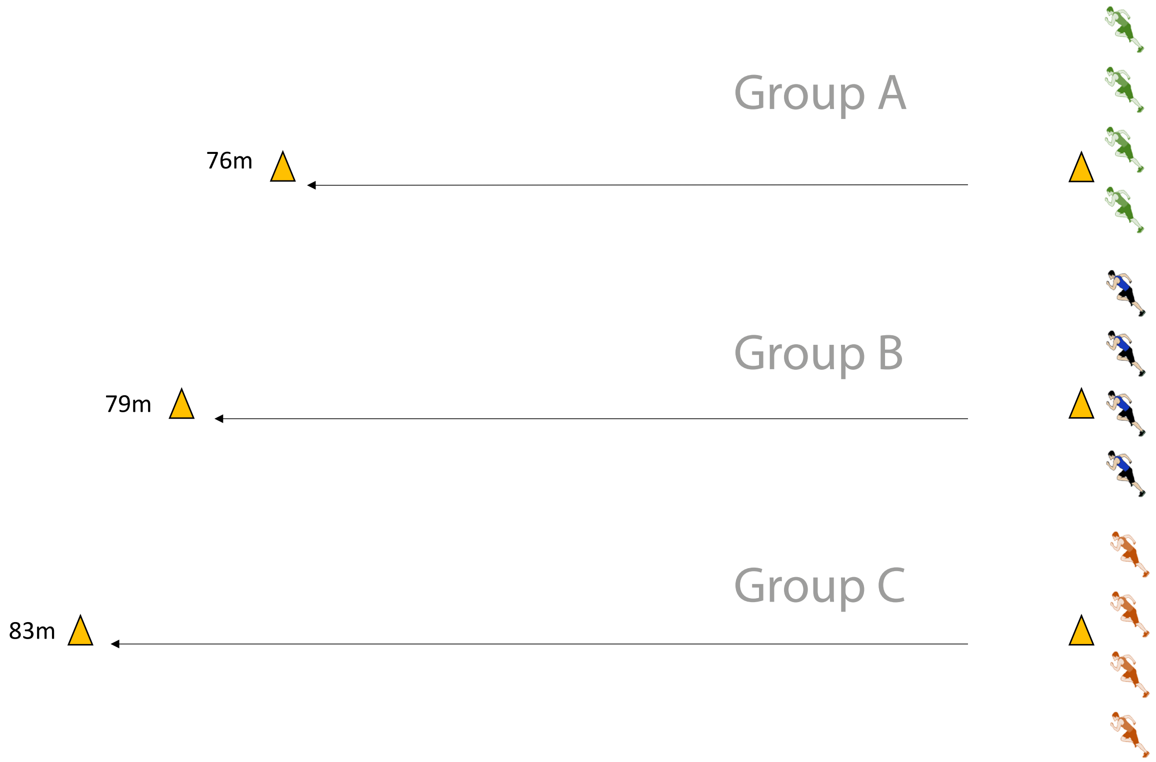
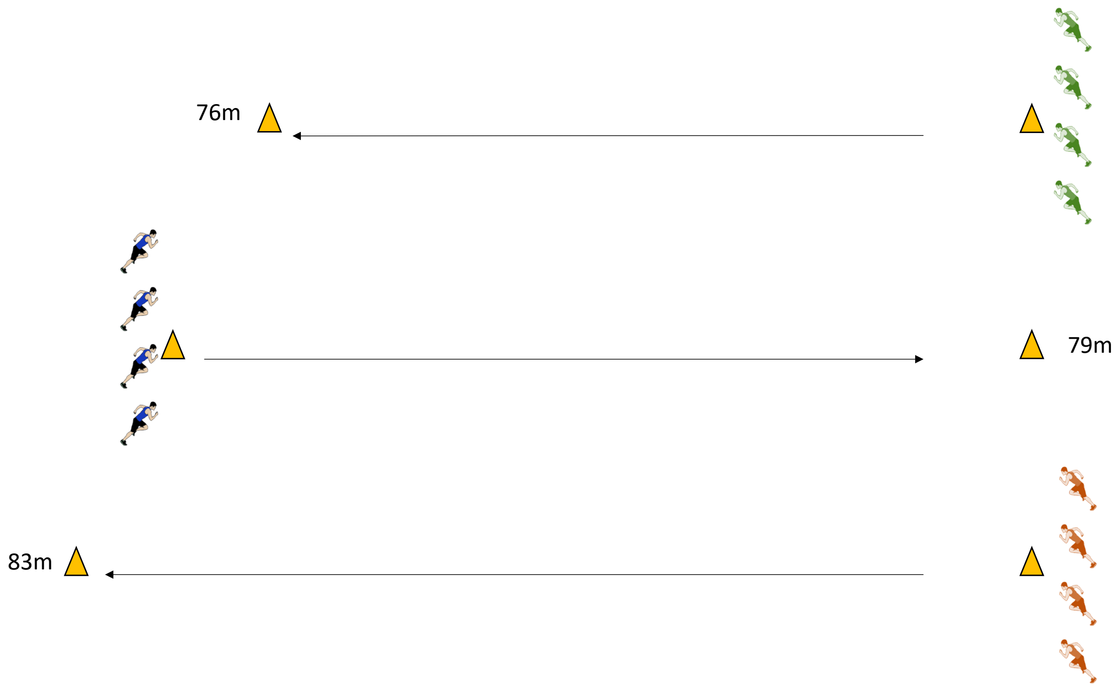


Figure 19. The common organization of groups in HIT conditioning sessions

This is quite convenient due to space restrictions and easier to setup by using markers and lines that are already on the field or pitch. But I have noticed one issue with this setup – athletes tend to sync between groups, consciously or subconsciously.

Athletes need to run the same speed within their own group so they should sync between themselves, inside the group. Giving beeps or whistle blows and counting out loud helps with this. The problem is the athletes on the margin of the groups (i.e. between two different groups), because they tend to sync as well and create perturbances within their own groups.

The solution to this issue is to have the group lanes either in different positions on the field, or alternate the start of the athletes, as depicted in the figure below:


76m
79m
83m

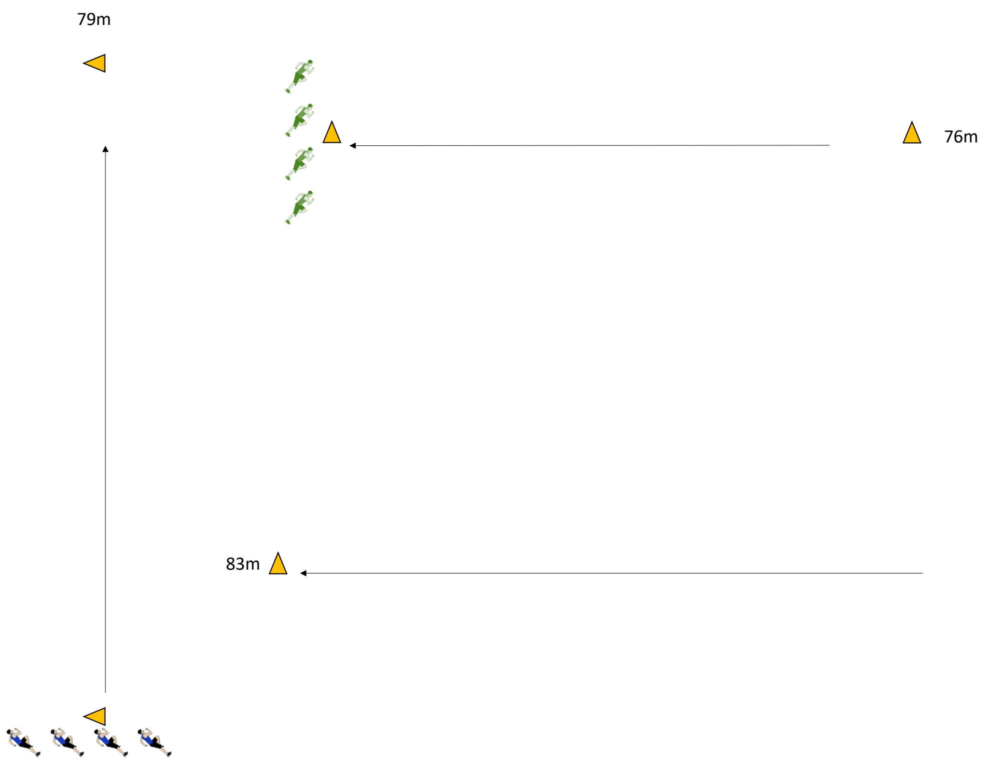

79m
76m
83m

Figure 20. Different ways of setting up groups to avoid synchronization *between groups.*

This might be a major pain in the ass to setup, but it is needed to avoid synchronization between groups. Keep in mind that we want synchronization ***within groups*** but no synchronization ***between groups***.

Individualization in prescription

The whole point of using individual MAS, IFT and ASR is to individualize HIT prescription (Baker, 2011; Buchheit & Laursen, 2013a; 2013b). When we do this, we automatically assume that by individualizing prescription, we also normalize (or equalize) training stimuli and hence training adaptation. But this is far from the truth. Let's expand on these problems and how they affect prescription and later planning strategies.

I am pretty sure that only a fool will assume the same level of effort (and hence fatigue) between two athletes when they perform, say 80m in 15 seconds with a 15 second passive break for 6 minutes. Their acute, internal reaction to this external prescription will depend on their individual characteristics. It is like having two athletes lift 110kg on the bench press without knowing their maximum (1RM).

Of course, we can give them a subjective prescription, such as "Run at an effort level of 7 out of 10" and so forth, but let's get back to the reality of coaching a dozen athletes at the same time. We need a more objective prescription while taking into account individual differences.

One way to achieve this is to express HIT velocity as a percentage of individual MAS, for example 15 seconds at 100% MAS. This way each athlete will get an 'individualized' prescription and hence their effort and fatigue levels will be more 'aligned' (please note my choice of words, because I said ***more aligned***, rather than same), as opposed to prescribing by using 80m in 15sec for everyone.

Let's assume we have two athletes with a MAS of 4.72 m/s (17 km/h), and we prescribe 15 sec intervals at 130% MAS (1.3 x 4.72 or 6.14 m/s) with 30 seconds passive rest (I will cover other HIT variations later in the text). Are they running at a similar level of 'effort' and will this elicit a similar level of stress and fatigue? What if their MSS differs, as depicted below?

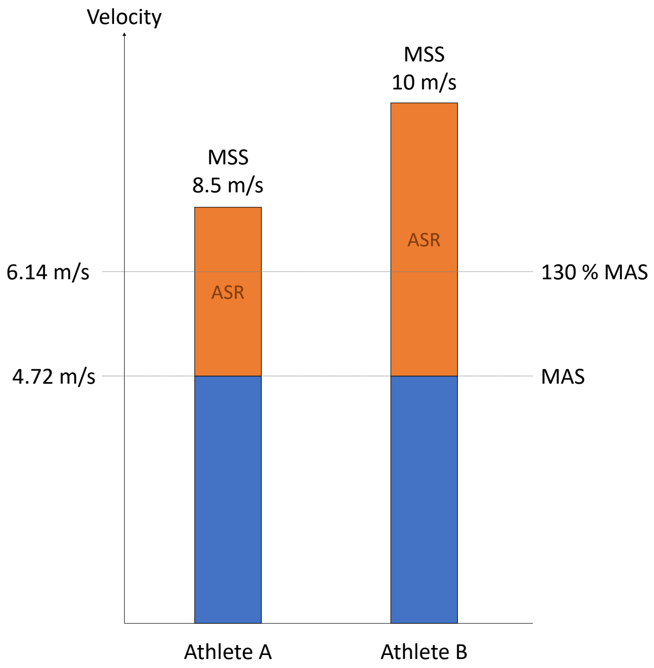


Figure 21. Just because you have used %MAS to prescribe, doesn't mean you have done a good job

From the picture above, we can see that even if the athletes have the same MAS and the HIT drill is individualized by using 130% MAS, they are not performing on the same level of 'effort.'

In this case, Athlete A is running at 37% ASR and Athlete B is running at 27% ASR. If you remember, we mentioned that a certain %ASR can be held for a certain amount of time (regardless of MAS and MSS), and the formula for that time is:

$$Time = \frac{\log_e(\frac{100}{\%ASR})}{k}$$

Equation 2. Mathematical equation for estimating time (Tlim) one is able to withstand running at certain %ASR

Here, the coefficient k is equal to 0.013 (Bundle & Weyand, 2012; Weyand, 2005).

If we plug in 37% and 27% ASR, we get 76 seconds for Athlete A, and 101 seconds for Athlete B. When we use a 15 sec interval, we can quickly see that Athlete A is using 15/76 or 20% of his ***maximum*** and Athlete B is using 15/101 or 15% of his ***maximum***. Long story short - using solely MAS is precise enough for 90-110% MAS velocity zones, but above that one should use ASR, and below, most likely vGET, vVT1, vVT2, or even heart rate. Since these zones below 85-90% MAS are not our concern in HIT conditioning, we will not dwell on these topics. The key message is that different velocity brackets demand different approaches for individualizing prescription.

Buchheit's IFT is useful for HIT prescription in velocity ranges from 100% to 130% MAS (90-110% IFT) (Buchheit & Laursen, 2013a; 2013b). For this reason, even though I am a big fan of the 30-15IFT test, I prefer MAS and MSS, since they provide a more prescriptive range.

In the table below, I roughly summarized what parameters should be used for prescription within certain velocity bands.

Velocity band	Prescribe using
>130% MAS	ASR
110-130% MAS	VIFT, ASR
90-110% MAS	MAS
70-90% MAS	CV, vGET, vVT2, HRmax
<70% MAS	vVT1, HRmax

Table 3. Depending on velocity band, using different parameters for prescription will be needed

Using time or distance?

Let's assume that you are preparing for a marathon and you hear that marathoners perform around 100km weekly volume. So you decide to do the same. But what are the differences between you, the marathoning rookie, and an experienced runner? There are plenty, but for sake of this example, your average running pace is much slower than the average pace for an experienced runner. The effect of this will be that it might take you 10 hours of running to cover 100km and someone who is more advanced might take 6-7 hours. Long story short, you will suffer more stress for the same distance.

The take home message is that we should use ***time***, rather than distance to ***normalize*** between athletes. I am aware that this is a bit of a distant example for HIT conditioning, but the logic is similar - to ***align*** individuals (although perfect alignment is the lab coats' wet dream, and it is unrealistic as I will soon explain) as much as possible, we need to use time, as well as time spent at a certain %MAS or %ASR.

Besides, using time allows for easier organization of group workouts, since everyone starts and stops at the same instant. Using time also makes training more controllable and it is easier to hold athletes accountable since you can quickly see who is slacking and who is not.

As covered earlier, some HIT drills might be easier done at a set distance (such as tempo running, or long intervals), so I am not completely against using distance for prescription.

What are stimuli?

Now we are happy since we managed to align our athletes in terms of individual effort (and hence stress) as much as possible, by using %MAS and %ASR. This is indeed a step in the right direction (individualization), but we cannot assume that the athletes received same training stimuli, or even worse, will achieve the same adaptation. This is a pipe dream. But individualizing by using %MAS and %ASR is much better than nothing and definitely represents a step in the right direction.

We still don't know what causes (or stimulates) adaptations in endurance performance and will probably never will. It is overly simplistic to represent endurance performance with MAS and it is even worse to assume that time spent at VO_2peak (T@ VO_2peak), or time spent at MAS (T@MAS) is the stimuli for the adaptation (Buchheit & Laursen, 2013a; 2013b). Things are not that simple and predictive.

Our brains crave predictability and simple causality, so when we identify certain constructs, qualities or determinants of performance, we immediately assume that there is a certain training zone or method that improves those qualities and hence improves performance. For example, as soon as we become aware of MAS, VO_2peak, vGET, LT and so forth, as determinants of performance, we immediately assume that there are certain velocity zones that improve these qualities (i.e. doing HIT conditioning at 100-110% MAS improves VO_2max, doing 75-85% MAS improves lactate threshold and so forth). Unfortunately, this is overly simplistic and fallacious.

Besides, most of these qualities are estimated from performance itself, so it is hard to say what comes first – the chicken or the egg, or construct improvement or performance improvement. Thinking in these deterministic buckets represents a warm comfort, but reality is much more complex.

It would be too simplistic to conclude, as depicted on the following image, that we perform HIT conditioning to spend more time at VO_2peak, which in turn stimulates adaptation and improves MAS, which results in improved performance.

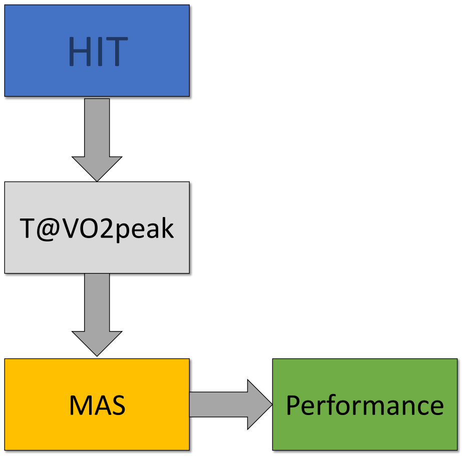


Figure 22. Overly simplistic and fallacious causal diagram of defining the objective of HIT conditioning to be more time spend at VO_2peak

In this ***causal diagram***, there might be third or fourth variables we are not even aware of, there might be expected and unexpected events and so forth (Pearl, Glymour, & Jewell, 2016; Rohrer, 2018). Besides, doing HIT might not solely be aimed at improving MAS of IFT, or directly endurance. It might also be aimed at improving the robustness of the athletes (i.e. doing tempo HIT drills prepare athletes for more strenuous sprinting), it might also involve "topping up" velocity zones to help in load management (explained later), it might provide variety, or it might provide fatiguing or differential scenarios that can help with skill acquisition and polishing (e.g. performing HIT conditioning between set piece practice in soccer). Again, things are not so simple and exact as we would want them to be.

A better model, depicted below, is taken from ***Complexity Explorer*** and does a wonderful job visualizing the complexities between stimulus and response:

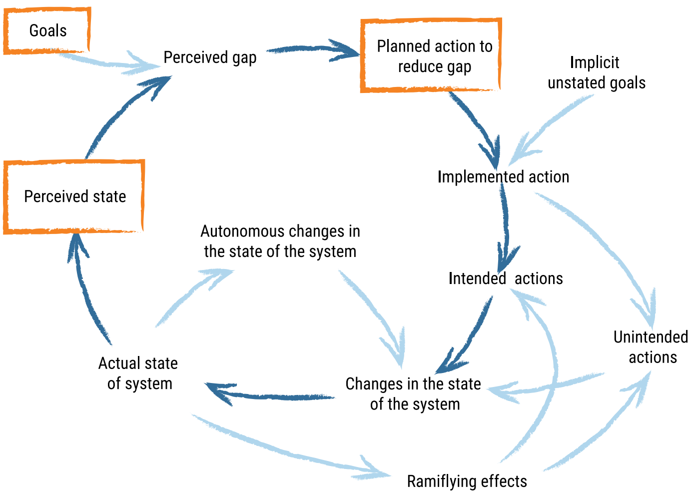


Figure 23. Complex causal network where cause and effect are not clear cut. Image modified based on Complexity Explorer, available at https://www.complexityexplorer.org/

I will take these issues into account when discussing appropriate planning strategies that are satisficing (good enough, robust) in dealing with such complexities and uncertainties, by using ***Agile Periodization***, as opposed to fallacious and comforting periodization strategies that are based on (the assumption of) predictability and (assumptions of) known stimuli. But before that, let me walk you through HIT Drills.

HIT Drills

Here is the classification of HIT drills used in this manual, mostly influenced by the outstanding work of Martin Buchheit **et al.** (Buchheit & Laursen, 2013a; 2013b) and Dan Baker (Baker, 2011):

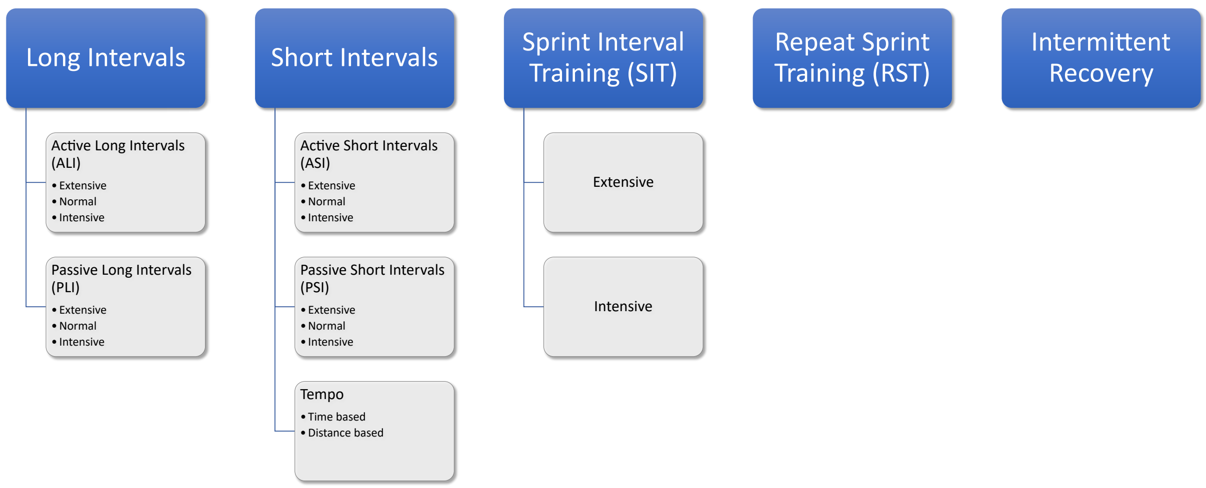


Figure 24. Classification of HIT drills

Each of these will be covered in more detail, but for the sake of a ***big picture*** overview, here is the Velocity Profile for Athlete A (MAS 4.44 m/s, MSS 9 m/s) with the distribution of HIT Drills (right side):

Velocity	%MSS	%ASR	Tlim	Dist	%VIFT	%MAS		REC	ALI	PLI	ASI	PSI	Tempo	SIT	RST
9.00	100%	100%	0 sec	0 m	177%	203%	MSS								
8.77	97%	95%	4 sec	35 m	173%	198%									95%
8.54	95%	90%	8 sec	69 m	168%	192%									90%
8.32	92%	85%	13 sec	104 m	164%	187%									
8.09	90%	80%	17 sec	139 m	159%	182%								80%	
7.86	87%	75%	22 sec	174 m	155%	177%								75%	
7.63	85%	70%	27 sec	209 m	150%	172%								70%	
7.40	82%	65%	33 sec	245 m	146%	167%								65%	
7.18	80%	60%	39 sec	282 m	141%	162%								60%	
6.95	77%	55%	46 sec	320 m	137%	156%							55%	55%	
6.72	75%	50%	53 sec	358 m	132%	151%							50%		
6.49	72%	45%	61 sec	399 m	128%	146%							45%		
6.26	70%	40%	70 sec	442 m	123%	141%							40%		
6.04	67%	35%	81 sec	487 m	119%	136%							35%		
5.81	65%	30%	93 sec	538 m	114%	131%						30%	30%		
5.58	62%	25%	107 sec	595 m	110%	126%						25%	25%		
5.35	59%	20%	124 sec	663 m	105%	121%					121%	20%	20%		
5.12	57%	15%	146 sec	748 m	101%	115%	VIFT				115%	15%			
4.90	54%	10%	177 sec	867 m	96%	110%				110%	110%	10%			
4.67	52%	5%	230 sec	1076 m	92%	105%				105%	105%	5%			
4.44	49%	0%	4-8min		88%	100%	MAS		100%	100%	100%	0%			
4.22	47%				83%	95%			95%	95%	95%				
4.00	44%				79%	90%			90%	90%	90%				
3.77	42%				74%	85%			85%						
3.55	39%				70%	80%			80%						
3.33	37%				66%	75%									
3.11	35%				61%	70%		70%							
2.89	32%				57%	65%		65%							
2.66	30%				53%	60%		60%							
2.44	27%				48%	55%		55%							
2.22	25%				44%	50%		50%							
2.00	22%				39%	45%									
1.78	20%				35%	40%									
1.55	17%				31%	35%									
1.33	15%				26%	30%									
1.11	12%				22%	25%									
0.89	10%				18%	20%									
0.67	7%				13%	15%									
0.44	5%				9%	10%									
0.22	2%				4%	5%									
0	0%				0%	0%		MAS	MAS	MAS	All	IFT/ASR	ASR	ASR	ASR

Figure 25. Example Velocity Profile and HIT drills distribution for Athlete A (MAS 4.44 m/s, MSS 9 m/s)

Here REC stands for recovery interval, performed in ***active*** variations of HIT drills, which is around 50-70% MAS. These two images provide a big picture of the HIT drills. Let's now cover each category in more detail.

Long Intervals

Long intervals are intervals longer that 1min, usually performed from 80% MAS to 110% MAS. In this manual we differentiate between two variations: long intervals with active rest (ALI; Active Long Intervals) and long intervals with passive rest (PLI; Passive Long Interval).

Since long intervals are well, long, coaches prefer to prescribe them using distance. As explained previously, prescription in distance is fine when working with a rather small number of athletes, but not when working with a big group. For example, if they run 800m using their individual work and recovery times, it can become quite messy and chaotic because everyone will start and stop at different times.

The solution for these longer intervals, when prescribing for a bigger group, would be to prescribe them in shuttles and use time rather than distance.

Let's take again Athlete A with a MAS of 4.44 m/s (16 km/h) and a MSS of 9 m/s (32.4 km/h) and prescribe passive long intervals (PLI) of 3 minutes work at 100% MAS with 6 minutes of passive rest. The distance that needs to be covered in those 3 minutes is 800m. That would be easily done if Athlete A is training alone. But let's say he has 30 more training mates and the coach decides to organize them in 10 shuttles of 77 meters (corrected for 0.7s COD loss), with a beep every 18 seconds (one shuttle needs to be covered in 18 seconds, which is equal to 180sec / 10 shuttles). This is all easily calculated in the HIT Builder.

Let's look at the differences between passive (PLI) and active (ALI) long intervals.

Passive Long Intervals (PLI)

Passive long intervals have a passive break between intervals. During that break, athletes can stand or walk. Usually they talk. This passive break allows for a slightly higher intensity (expressed in % MAS) compared to active break long intervals (see the Long Intervals table).

In this manual, I differentiate between intensive, normal, and extensive variations, which involve 1:2, 1:1, and 2:1 work-to-rest ratio. The following graph will convey the message, in addition to the long intervals table (Table 4).

HIT Name		Work Interval				Rest Interval			Set information			
		Duration	MAS	IFT	ASR	Duration	MAS	IFT	W:R	Format	# of Sets	Rest btwn sets
Passive Long Intervals (PLI)												
Int	**1':2'**	60sec	100-110%	*85-95%*	*0-10%*	120sec	passive		1:2	10-15 x 1min	1-2sets	3-5min
	1'30':3'	90sec	100-110%	*85-95%*	*0-10%*	180sec	passive		1:2	8-12 x 90sec	1-2sets	3-5min
	2':4'	120sec	100-110%	*85-95%*	*0-10%*	240sec	passive		1:2	6-10 x 2min	1-2sets	4-6min
	3':6'	180sec	100-110%	*85-95%*	*0-10%*	360sec	passive		1:2	5-8 x 3min	1-2sets	5-7min
Norm	**1':1'**	60sec	95-105%	*80-90%*		60sec	passive		1:1	10-15 x 1min	1-2sets	3-5min
	1'30':1'30	90sec	95-105%	*80-90%*		90sec	passive		1:1	8-12 x 90sec	1-2sets	3-5min
	2':2'	120sec	95-105%	*80-90%*		120sec	passive		1:1	6-10 x 2min	1-2sets	4-6min
	3':3'	180sec	95-105%	*80-90%*		120sec	passive		1:1	5-8 x 3min	1-2sets	5-7min
Ext	**1':30''**	60sec	90-100%	*75-85%*		30sec	passive		2:1	10-15 x 1min	1-2sets	3-5min
	1'30:45''	90sec	90-100%	*75-85%*		45sec	passive		2:1	8-12 x 90sec	1-2sets	3-5min
	2':1'	120sec	90-100%	*75-85%*		60sec	passive		2:1	6-10 x 2min	1-2sets	4-6min
	3':1'30	180sec	90-100%	*75-85%*		90sec	passive		2:1	5-8 x 3min	1-2sets	5-7min
Active Long Intervals (ALI)												
Int	**1':2'**	60sec	90-100%	*75-85%*		120sec	60-70%	*50-60%*	1:2	10-15 x 1min	1-2sets	3-5min
	1'30':3'	90sec	90-100%	*75-85%*		180sec	60-70%	*50-60%*	1:2	8-12 x 90sec	1-2sets	3-5min
	2':4'	120sec	90-100%	*75-85%*		240sec	60-70%	*50-60%*	1:2	6-10 x 2min	1-2sets	4-6min
	3':6'	180sec	90-100%	*75-85%*		360sec	60-70%	*50-60%*	1:2	5-8 x 3min	1-2sets	5-7min
Norm	**1':1'**	60sec	85-95%	*70-80%*		60sec	55-65%	*45-55%*	1:1	10-15 x 1min	1-2sets	3-5min
	1'30':1'30	90sec	85-95%	*70-80%*		90sec	55-65%	*45-55%*	1:1	8-12 x 90sec	1-2sets	3-5min
	2':2'	120sec	85-95%	*70-80%*		120sec	55-65%	*45-55%*	1:1	6-10 x 2min	1-2sets	4-6min
	3':3'	180sec	85-95%	*70-80%*		120sec	55-65%	*45-55%*	1:1	5-8 x 3min	1-2sets	5-7min
Ext	**1':30''**	60sec	80-90%	*65-75%*		30sec	50-60%	*40-50%*	2:1	10-15 x 1min	1-2sets	3-5min
	1'30:45''	90sec	80-90%	*65-75%*		45sec	50-60%	*40-50%*	2:1	8-12 x 90sec	1-2sets	3-5min
	2':1'	120sec	80-90%	*65-75%*		60sec	50-60%	*40-50%*	2:1	6-10 x 2min	1-2sets	4-6min
	3':1'30	180sec	80-90%	*65-75%*		90sec	50-60%	*40-50%*	2:1	5-8 x 3min	1-2sets	5-7min

Table 4. Long intervals

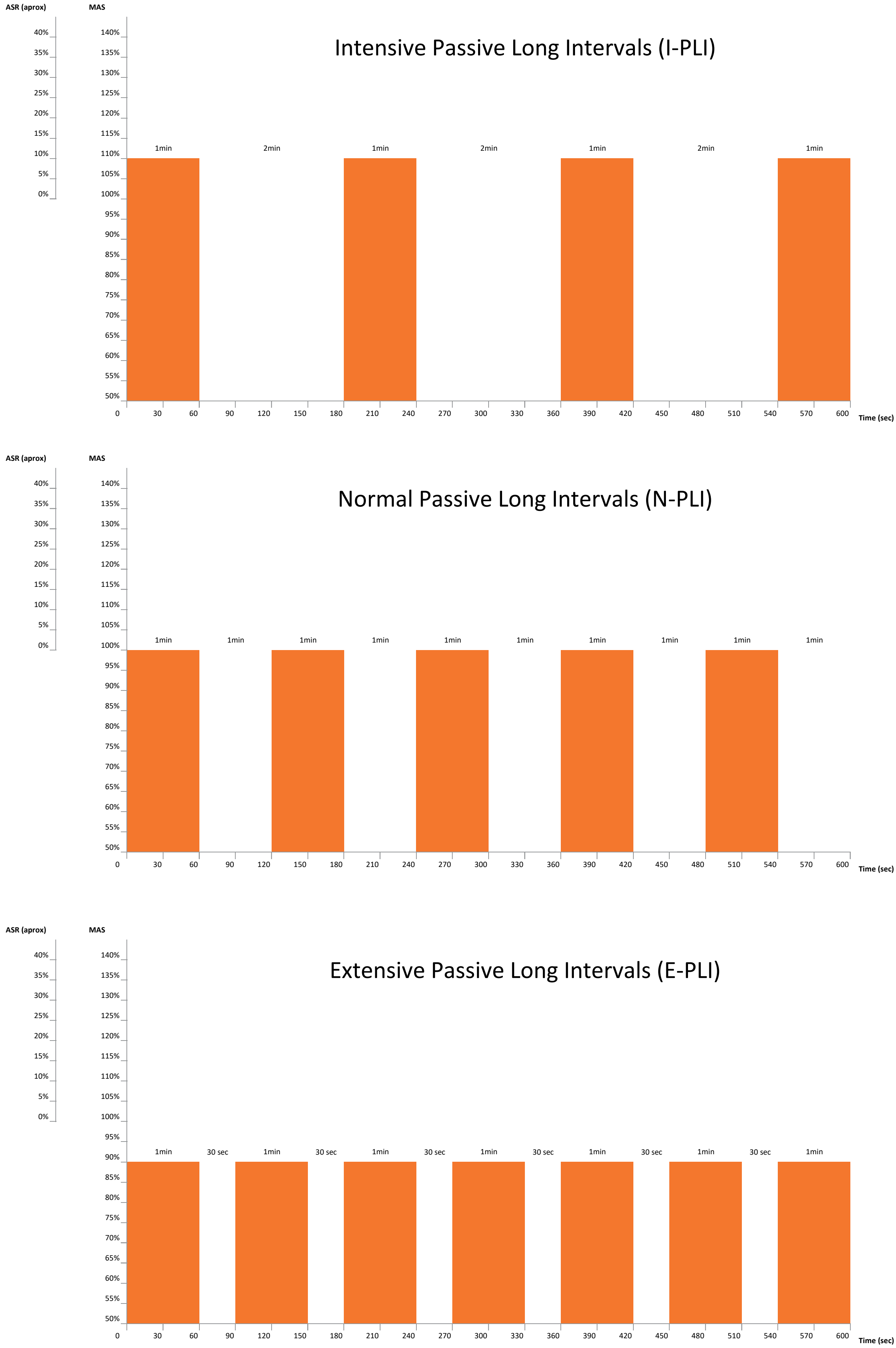


Figure 26. Passive Long Intervals (PLI)

Active Long Intervals (ALI)

Active long intervals (ALI) involve an active recovery period in which the athlete needs to (in this case) run at 50-70% MAS. To be completely honest, this is always tricky with team sport athletes (in general, but with active long intervals in particular) and much easier to convey with Track & Field athletes. One solution, with long intervals that are performed in shuttles, would be to cover the same distance in double time (with intensive variations, which use a 1:2 work-to-rest ratio), cover half the shuttles in same time (with normal variations, which use a 1:1 work-to-rest ratio), or cover 1/4 shuttles in half the time (with extensive variations, which use a 2:1 work-to-rest ratio).

Let's take Athlete A (MAS 4.44 m/s, MSS 9 m/s) as an example again. Prescribing an active long interval of 2 minutes at 90% MAS with 2 minutes at 55-65% MAS, in 8 shuttles, Athlete A will need to cover 8x57m (480m total). During the 2 minute break, he would need to cover 4x57m, which is not exactly 55-65% (rather 45% MAS), but much easier to organize and perform. If you want to be a lab coat and nitpick, go ahead and measure the exact distance. Or just do one more shuttle, 5x57m in 2minutes; Problem solved.

As with passive long intervals, here I differentiate between three variants: intensive (1:2), normal (1:1), and extensive (2:1). They are depicted in the image below, but also consult the long intervals table.

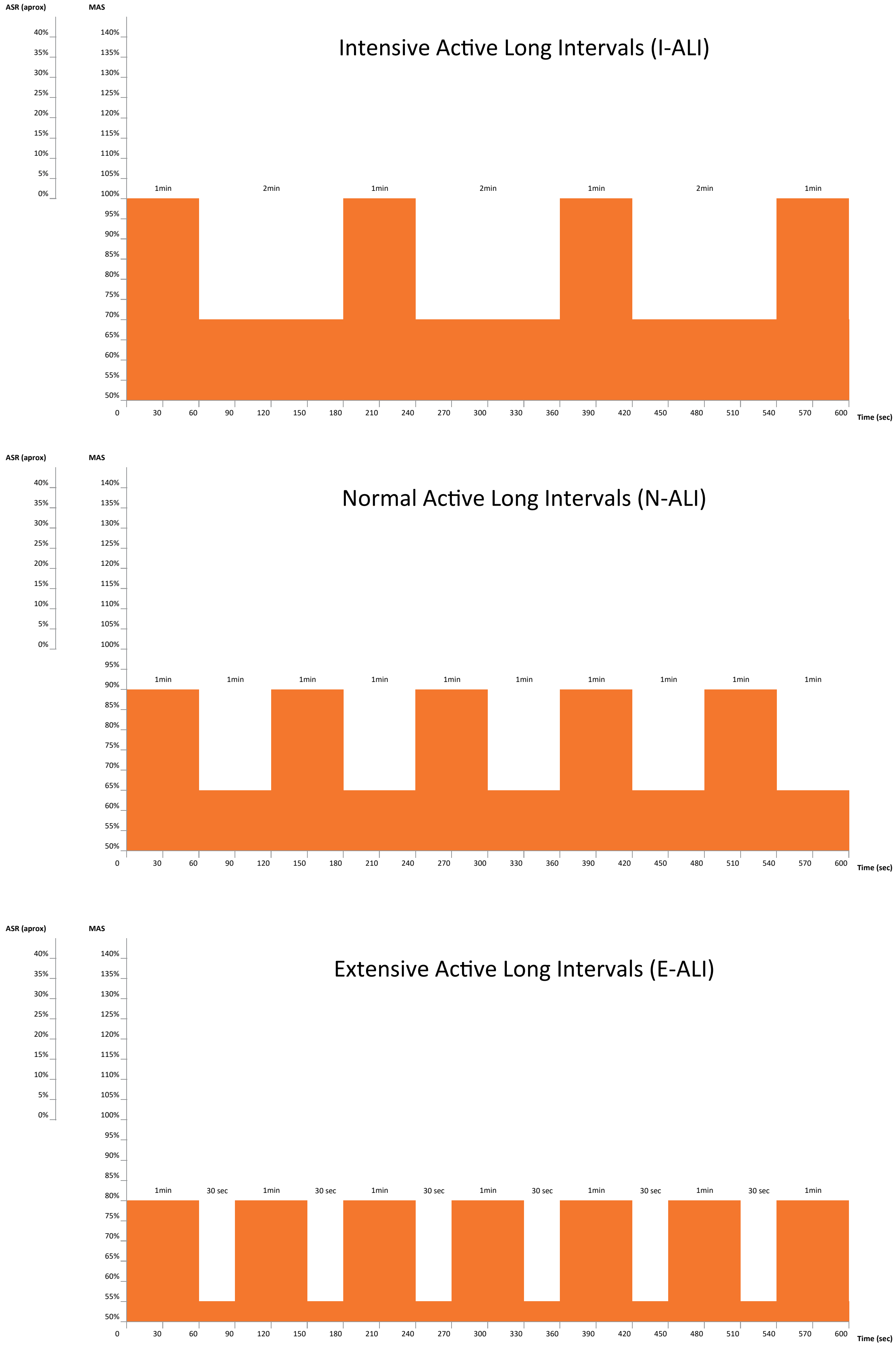


Figure 27. Active Long Intervals (ALI)

Long Intervals format

One set of long intervals can/should be longer than 20-30 minutes (e.g. long intervals 3'-3' takes 6 minutes for one repetition, so doing 4x3min is already a 24 minute long set). For this reason, long intervals are usually performed for one set only (two tops). In team sports, athletes are already time constrained and for that sole reason, long intervals are usually not very frequently performed. They are most likely to be performed when there are not many sport practices (as in the off season), when the athlete is in the rehab phase after an injury, or when the athlete has a really shitty MAS score (coaching wisdom suggests that lower level athletes should spend more time flirting with longer intervals). I am an advocate of performing them occasionally throughout the season for the sake of variety and covering more 'extensive' ranges of conditioning every now and then. More about this in the chapter on planning.

Progressions with Long Intervals

First of all, what is progression? In plain English, progression is making things harder (under the same variation). HIT has a lot of variables that can be manipulated in order to make intervals harder. Here are few heuristics you can play with (in no particular order, although increasing volume before intensity is a viable strategy):

1. Increase overall duration by increasing the number of repetitions in a set (e.g. from 10x1min to 15x1min)
2. Increase overall duration by increasing the number of sets (e.g. from 2x8x1min to 3x6x1min)
3. Decrease the recovery time between intervals (e.g. from 1min work 1min rest, to 1min work to 45sec rest)
4. Extend the duration of the work interval (e.g. from 1min work 1min rest, to 1:15 work 1min rest)
5. Increase the intensity in the active recovery phase (e.g. from 45% to 55%, or from 4x57m in the above example, to 6x57m)
6. Increase the intensity of the work interval (e.g. from 100% to 105% MAS)

Rule #6 can also be seen as actually increasing an individual's MAS by 0.25-0.5 km/h (0.07-0.14 m/s) from training phase to training phase. You can use either strategy, whichever is smaller (but bear in mind that increasing an athletes' MAS will affect all other HIT drills, where increasing a specific drill's %MAS will affect only that drill). On the following table I have provided the distance that needs to be covered in 2min at 90% MAS for Athlete A and how that distance changes when we either increase intensity from 90% to 95% MAS, or add 0.5km/h (0.14 m/s) to his MAS (from 4.44 to 4.58 m/s):

Athlete A (2min at 90% MAS)		
%MAS	MAS	Distance
90%	4.44	480m
95%	4.44	506m
90%	4.58	495m
95%	4.58	563m

Table 5. Two different strategies of progressing intensity in HIT drills (1) increasing %MAS or (2) increasing MAS itself

As can be seen from the table, increasing work intensity from 90 to 95% MAS increases the distance from 480m to 506m. On the other hand, adding 0.14 m/s to the Athlete A's MAS (from 4.44 m/s to 4.58 m/s) increases the distance from 480m to 495m.

Similar to strength training, we can increase the work intensity inside the phase (e.g. 87.5%, 90%, 92.5%, 95% MAS) and then increase the individual's MAS and restart the cycle at the start of the next phase. This way we will get neat **waving** of the load (see the below table and graph).

	Athlete A (2min at 90% MAS)		
	%MAS	MAS	Distance
Phase #1	87.5%	4.44	466
	90.0%	4.44	480
	92.5%	4.44	493
	95.0%	4.44	506
Phase #2	87.5%	4.58	481
	90.0%	4.58	495
	92.5%	4.58	508
	95.0%	4.58	522

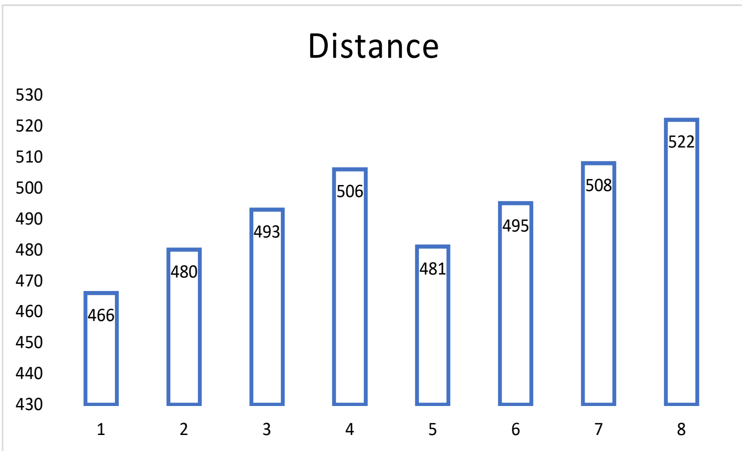


Figure 28. Waving load effect by repeating the same HIT progression, but increasing MAS from phase to phase

This ***waving*** cycle can work with other progression variations as well - create 3-4 progression steps for the above six progression heuristics, perform them (e.g. next step every time the same session is repeated) and once all steps are done (in few weeks), restart the cycle and increase the athletes' MAS (for 0.25-0.5 km/h) or perform a retest using SRBT.

Combining active long intervals (ALI) and passive long intervals (PLI) with extensive, normal and intensive variants, together with the above different progression strategies will give you numerous HIT conditioning options. Planning will be covered in greater detail in the following chapters.

Short Intervals

Short intervals are intervals shorter that 1min (most likely shorter than 30sec) and are usually performed from 100% MAS to 130+% MAS (tempo intervals are performed higher than 130% MAS). In this manual we differentiate between three variations: short intervals with active rest (ASI), short intervals with passive rest (PSI), and tempo running.

HIT Name		Work Interval				Rest Interval			Set information			
		Duration	MAS	IFT	ASR	Duration	MAS	IFT	W:R	Format	# of Sets	Rest btwn sets
Passive Short Intervals (PSI)												
Int	10:20	10sec	*120-130%*	102.5-110%	20-30%	20sec	passive		1:2	4-8min	2-6sets	3-5min
	15:30	15sec	*120-130%*	102.5-110%	20-30%	30sec	passive		1:2	4-8min	2-6sets	3-5min
	20:40	20sec	*120-130%*	102.5-110%	20-30%	40sec	passive		1:2	4-8min	2-6sets	3-5min
	30:60	30sec	*120-130%*	102.5-110%	20-30%	60sec	passive		1:2	4-8min	2-6sets	3-5min
Norm	10:10	10sec	*110-120%*	95-102.5%	10-20%	10sec	passive		1:1	4-8min	2-6sets	3-5min
	15:15	15sec	*110-120%*	95-102.5%	10-20%	15sec	passive		1:1	4-8min	2-6sets	3-5min
	20:20	20sec	*110-120%*	95-102.5%	10-20%	20sec	passive		1:1	4-8min	2-6sets	3-5min
	30:30	30sec	*110-120%*	95-102.5%	10-20%	30sec	passive		1:1	4-8min	2-6sets	3-5min
Ext	10:05	10sec	100-110%	85-95%	0-10%	5sec	passive		2:1	4-8min	2-6sets	3-5min
	15:07	15sec	100-110%	85-95%	0-10%	7.5sec	passive		2:1	4-8min	2-6sets	3-5min
	20:10	20sec	100-110%	85-95%	0-10%	10sec	passive		2:1	4-8min	2-6sets	3-5min
	30:15	30sec	100-110%	85-95%	0-10%	15sec	passive		2:1	4-8min	2-6sets	3-5min
	30:10	30sec	90-100%	*75-85%*		10sec	passive		3:1	4-8min	2-6sets	3-5min
	45:15	45sec	90-100%	*75-85%*		15sec	passive		3:1	4-8min	2-6sets	3-5min
Active Short Intervals (ASI)												
Int	10:20	10sec	*110-120%*	95-102.5%	10-20%	20sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
	15:30	15sec	*110-120%*	95-102.5%	10-20%	30sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
	20:40	20sec	*110-120%*	95-102.5%	10-20%	40sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
	30:60	30sec	*110-120%*	95-102.5%	10-20%	60sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
Norm	10:10	10sec	100-110%	85-95%	0-10%	10sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
	15:15	15sec	100-110%	85-95%	0-10%	15sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
	20:20	20sec	100-110%	85-95%	0-10%	20sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
	30:30	30sec	100-110%	85-95%	0-10%	30sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
Ext	10:05	10sec	90-100%	*75-85%*		5sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	15:07	15sec	90-100%	*75-85%*		7.5sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	20:10	20sec	90-100%	*75-85%*		10sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	30:15	30sec	90-100%	*75-85%*		15sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	30:10	30sec	80-90%	*65-75%*		10sec	45-55%	*35-45%*	3:1	4-8min	2-6sets	3-5min
	45:15	45sec	80-90%	*65-75%*		15sec	45-55%	*35-45%*	3:1	4-8min	2-6sets	3-5min
Tempo Strides												
Time	10:30	10sec	*135-145%*	115-125%	35-44%	30sec	passive		1:3	10-15min	2-5 sets	3-5min
	15:45	15sec	*130-140%*	110-120%	33-41%	45sec	passive		1:3	10-15min	2-5 sets	3-5min
	20:60	20sec	*130-140%*	105-115%	31-39%	60sec	passive		1:3	10-15min	2-5 sets	3-5min
	30:90	30sec	*125-135%*	102.5-110%	27-34%	90sec	passive		1:3	10-15min	2-5 sets	3-5min
	45:135	45sec	*120-130%*	100-105%	22-28%	135sec	passive		1:3	10-15min	2-5 sets	3-5min
	60:180	60sec	*115-125%*	95-102.5%	18-23%	180sec	passive		1:3	10-15min	2-5 sets	3-5min
Dist	100m	See Tempo Builder (Distance)					passive		1:3	10-15min	2-5 sets	3-5min
	200m						passive		1:3	10-15min	2-5 sets	3-5min
	300m						passive		1:3	10-15min	2-5 sets	3-5min
	400m						passive		1:3	10-15min	2-5 sets	3-5min

Table 6. Short Intervals

Short intervals are usually the most frequently performed HIT conditioning in team sports since they are the most ***similar*** to the competitive activity (short work and short break).

Passive Short Intervals (PSI)

Passive short intervals are the most commonly used variation of HIT conditioning (at least in team sports). They are easy to setup and athletes love them (if that could actually be said for any HIT conditioning; maybe they hate them the least?).

Passive short intervals are usually done in shuttles, although straight lines are also common. The selection depends on the context (which will be covered in the planning section of this manual).

There are three types: intensive (1:2 work-to-rest ratio), normal (1:1) and extensive (2:1 and even few examples of 3:1). The following picture shows distinctions for 20sec variations:

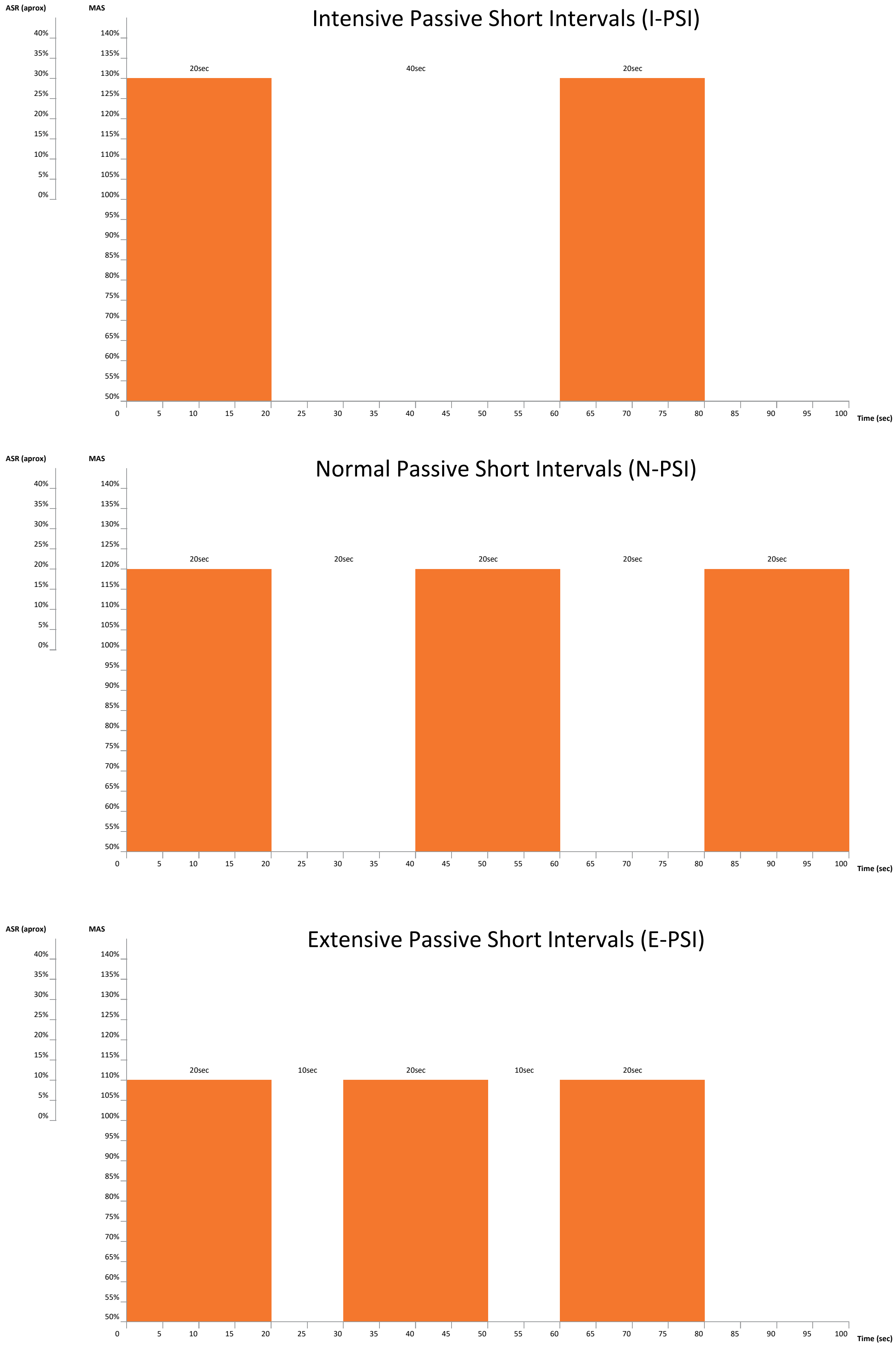


Figure 29. Passive Short Intervals (PSI)

Active Short Intervals (ASI)

Active short intervals are very equal to their evil twin brother, passive short intervals, but due to the short active recovery (50-70% MAS), the intensity of the work interval needs to be reduced a bit.

There are three variants of active short intervals: intensive (1:2 work-to-rest ratio), normal (1:1), and extensive (2:1 and even few examples of 3:1).

Similar to active long intervals, the active recovery phase can be precisely prescribed (if you are an obsessed lab coat), or the athletes can cover the same distance in double time (with intensive variations, with a 1:2 ratio), cover half the shuttles in same time (with normal variations, with a 1:1 ratio), or cover 1/4 shuttles in half the time (with extensive variations, with a 2:1 ratio).

There is a special format of normal (1:1) active short intervals, that I have learned from the great Dan Baker, called "aerobic grids" (Baker, 2011). So, rather than setting up shuttles, you can set up concentric grids:

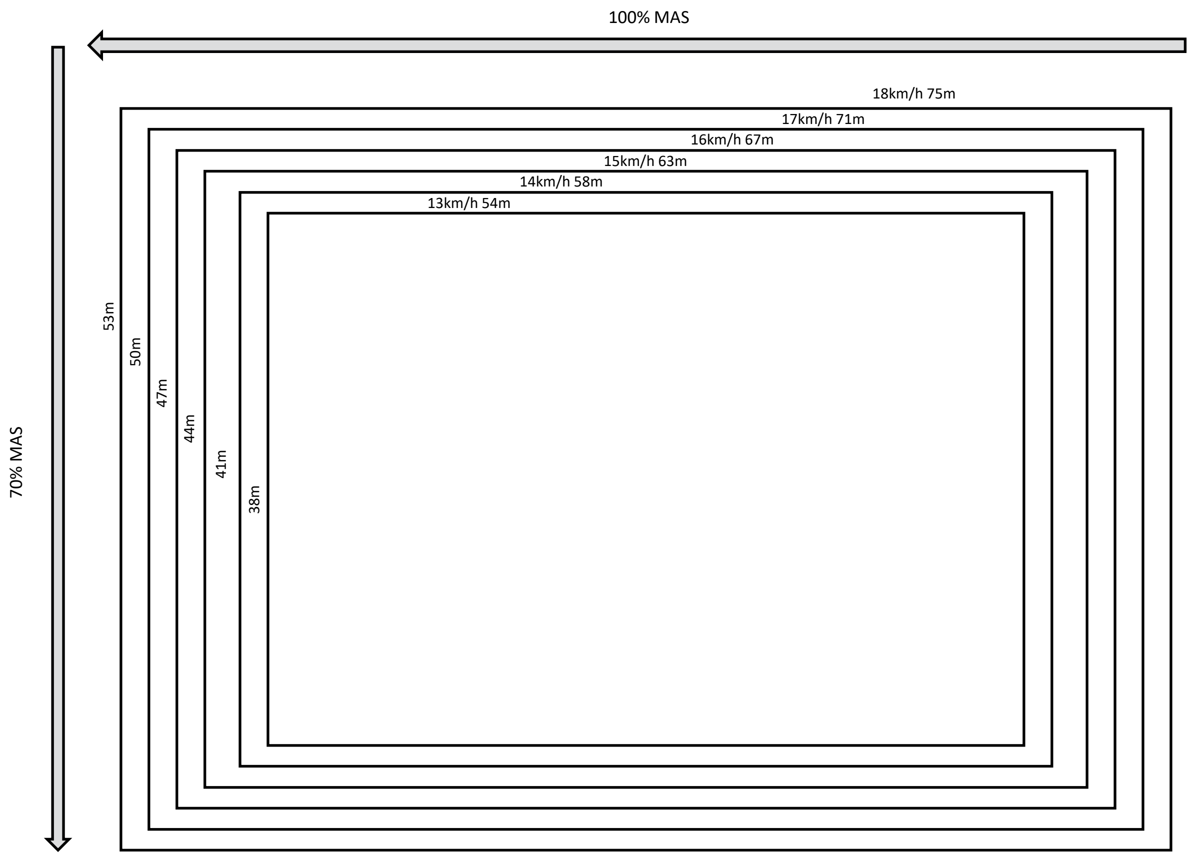


Figure 30. "Aerobic Grids" setup for Active Short Intervals (see Baker, 2011)

Here the athletes run at 100% MAS for 15 seconds and jog at 70% MAS for 15 seconds. Athletes can start from different corners and they can be placed in similar groups (i.e. with 2-7.5% difference between individual distance and grid distance).

The goal for the athletes is to come to the cone (corner) right at the beep. If they are faster, they should wait at the cone. If they are slower, they should speed up. The HIT shouldn't start looking like a medium intensity run at 85% MAS, but rather, the 100/70% MAS phases should be clearly distinguishable.

Another example might be shuttles. One group might run a 15:15 HIT at 110%/65% MAS that could be, say, 2x35m shuttles. During the recovery phase, they can run 1x35m in 15 seconds (this is around 55% MAS). If you want to be more precise, smaller shuttle lanes can be created for the recovery interval, but that could be overkill.

The following image contains intensive (1:2), normal (1:1), and extensive (2:1) variations of 20sec active short intervals (ASI):

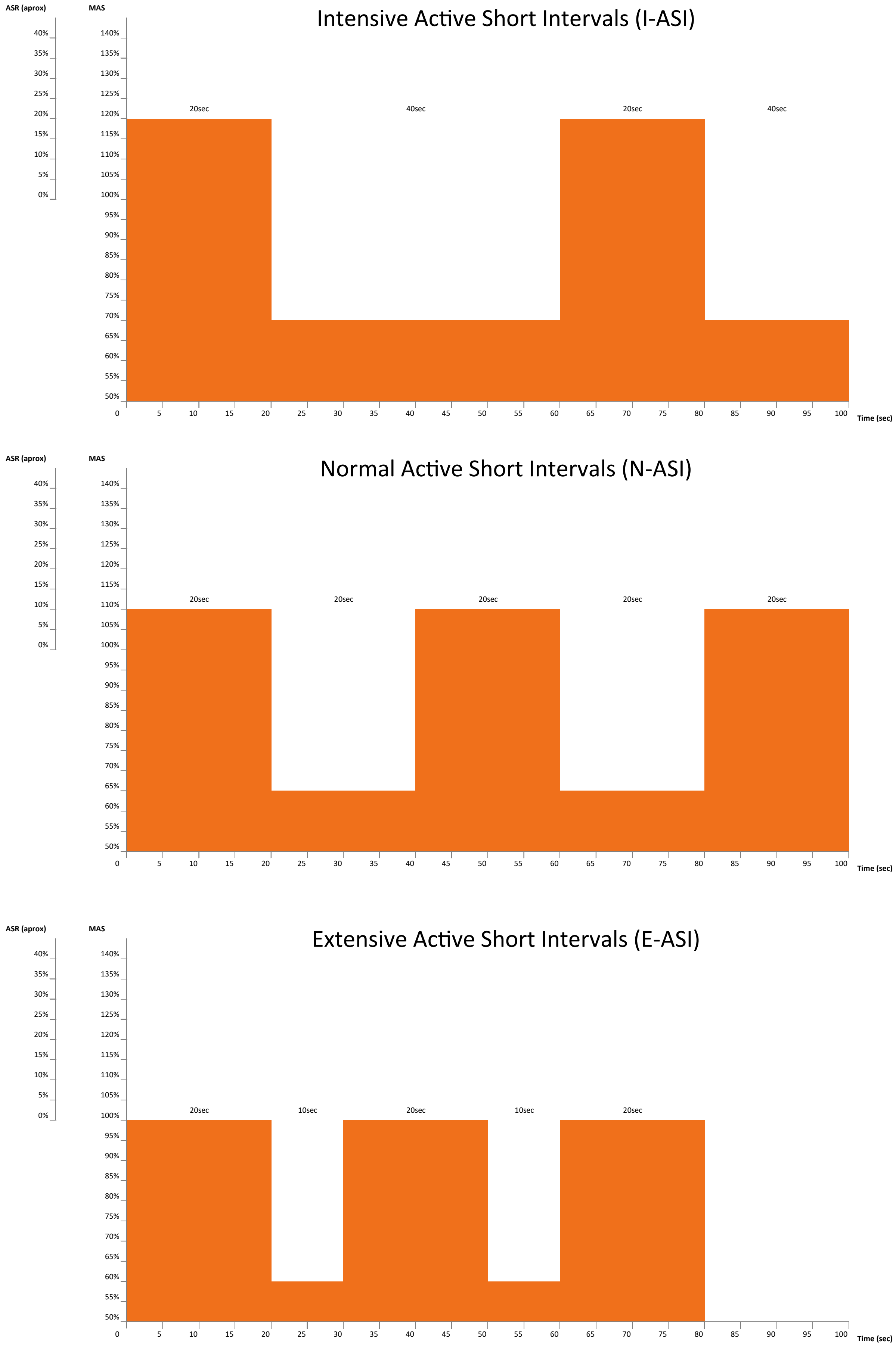


Figure 31. Active Short Intervals (ASI)

Tempo

If I could choose only one HIT drill variation, it would be tempo work. The sole reason for my choice is the accumulation of high-speed distance, with a long break, which is great for quality work and makes athletes more robust and prepared for running at high velocities. The average heart rate is around 140-160bpm (personal observation). This doesn't make tempo a great HIT variation if you look solely at T@VO2peak (which is a shortsighted approach in judging the effectiveness of HIT drills as a multitude of variables might be eliciting adaptations). But, if you take into account other metrics, it is definitely the best choice for HIT conditioning. As always, the problem are our insufficient mental models that would throw the baby out with the bathwater. In this case, the lab coats would ditch the tempo work because it doesn't maximize T@VO2peak.

The first time I heard about (extensive) tempo was from the late Charlie Francis (Francis & Patterson, 1992), who was a famous and highly influential sprint coach from Canada (and to whom I owe a lot). Charlie suggested doing tempo work at less than 70% of an athlete's best 100m time (e.g. if you run 11 seconds, then tempo should be done slower than 11 / 0.7 = 15.7 seconds), usually on soft grass (e.g. soccer pitch). The format is usually written as:

100+100+100+100

100+200+100+100+100

100+200+100+200+100

100+100+100+200+100

100+100+100+100

100s are runs at 70% of 100m time (e.g. 15-16 seconds) over the length of the soccer pitch and 200s are down and back (100m up, turn around, run 100m back). Pluses represent a 50m walk (width of the soccer pitch), usually for 40 seconds. The rest between sets is usually 2x50m walk and some ab circuits (Hansen, 2014)

If you only look at 100s, then the work-to-rest ratio is around 1:3 (e.g. 15sec run, 40sec walk). 200s are usually somewhere around 1:1 work-to-rest ratio (32sec run, 40sec walk), which makes them more similar to an intensive version of normal short intervals with a passive break (e.g. 30:30 at 120% MAS). For this reason, 200s are ***injected*** between series of 100s. I believe that this variability is important and I will cover this important concept in the planning section.

It is usually recommended to begin tempo work at around 60-70% of the best time in a 100m sprint

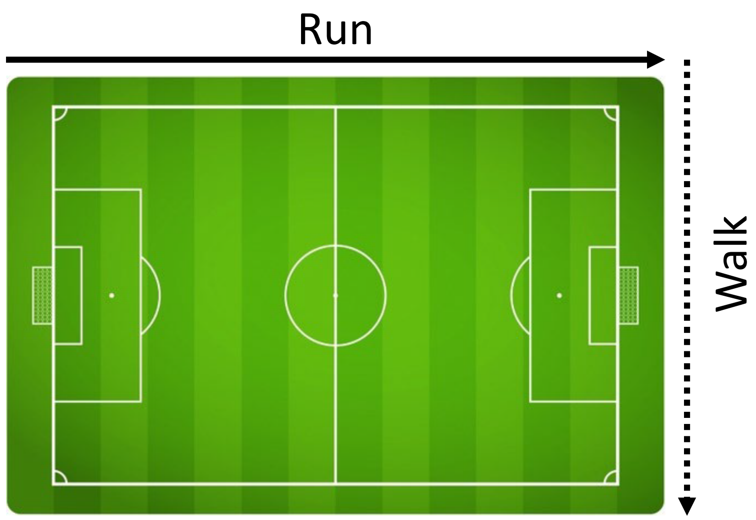


Figure 32. Extensive tempo conditioning on soccer pitch

(Hansen, 2014). Although this is a perfectly ***satisficing*** heuristic, I will try not to become a "precision, precision" lab coat here and say that we can do better than this (conditional on the assumption of the ASR model) to individualize tempo prescription. Below is the table with a few athletes and their 100m times (using their MAS and MSS scores to calculate it, without any start loss correction):

Athlete	MSS	MAS	100m time	%ASR	%MAS
Athlete A	9.00	4.44	12.00	85%	188%
Athlete B	10.00	3.75	10.90	87%	245%
Athlete C	9.09	4.64	11.85	85%	182%
Athlete D	10.54	3.70	10.35	87%	261%
Athlete E	10.94	3.83	9.90	88%	264%
Athlete F	10.11	5.24	10.55	87%	181%

Table 7. Six athletes with difference MSS and MAS values and estimated 100m times (flying) with calculated %ASR and %MAS values

What is quite obvious from the table is that athletes sprint 100m at different %ASR (because it takes them different amounts of time to do so). According to the ASR model, although athletes will run at a very similar %ASR for a given duration of the sprint (regardless of their MAS and MSS scores), this is not the case for distance, because each athlete will cover a specific distance in a specific time based on their MAS and MSS scores. The faster the athlete, the higher the %ASR will be for that distance (because it takes less time).

Now, let's take 70% of this time (or velocity) and check what happens with %ASR:

Athlete	MSS	MAS	70% 100m	%ASR	%MAS
Athlete A	9.00	4.44	17.14	31%	131%
Athlete B	10.00	3.75	15.57	43%	171%
Athlete C	9.09	4.64	16.93	28%	127%
Athlete D	10.54	3.70	14.79	45%	183%
Athlete E	10.94	3.83	14.14	46%	185%
Athlete F	10.11	5.24	15.07	29%	127%

Table 8. Using 70% of 100m time results in very different between-athletes %ASR estimates

It is quickly seen that using 70% of 100m time is not the best individualization strategy (at least from an ASR model perspective), since athletes will perform it at different %ASR (and hence, experience different ***effort*** or ***stress***, which we are trying to ***normalize*** or ***equalize*** between them).

A better approach will be to use time instead. For example, here is the potential best distance covered in 15 seconds:

Athlete	MSS	MAS	15sec Dist	%ASR	%MAS
Athlete A	9.00	4.44	123	82%	185%
Athlete B	10.00	3.75	133	82%	237%
Athlete C	9.09	4.64	125	82%	179%
Athlete D	10.54	3.70	140	82%	252%
Athlete E	10.94	3.83	145	82%	253%
Athlete F	10.11	5.24	139	82%	176%

Table 9. Using 15sec time instead of distance to prescribe extensive tempo HIT drills

Please compare that when using time, in this case 15sec; %ASR is same across individuals, as opposed when using 100m distance. This is due to the reasons already outlined. Let's do 70% of this distance (same as 70% of average velocity in 15 seconds):

Athlete	MSS	MAS	70% Dist	%ASR	%MAS
Athlete A	9.00	4.44	86	28%	129%
Athlete B	10.00	3.75	93	40%	166%
Athlete C	9.09	4.64	87	26%	125%
Athlete D	10.54	3.70	98	41%	176%
Athlete E	10.94	3.83	102	41%	177%
Athlete F	10.11	5.24	97	25%	124%

Table 10. Using 70% distance to prescribe extensive tempo intervals doesn't result in improved normalization of %ASR between-athletes

Not much of a better situation with the time interval since athletes end up at a different %ASR as well. Let me suggest another solution: **40-50%** of **ASR**. So if their maximum on 15 second intervals is 82% ASR, then tempo should be done at 50% of that, which is 41% ASR. Here is a table for 15 sec intervals:

							70% Velocity				50% ASR			
Athlete	MSS	MAS	Time	%ASR	Distance	Avg Velocity	Velocity	%ASR	%MAS	Distance	Velocity	%ASR	%MAS	Distance
Athlete A	9.00	4.44	15	82%	123	8.19	5.73	28%	129%	86	6.31	41%	142%	95
Athlete B	10.00	3.75	15	82%	133	8.89	6.22	40%	166%	93	6.31	41%	168%	95
Athlete C	9.09	4.64	15	82%	125	8.30	5.81	26%	125%	87	6.46	41%	139%	97
Athlete D	10.54	3.70	15	82%	140	9.33	6.53	41%	176%	98	6.50	41%	176%	98
Athlete E	10.94	3.83	15	82%	145	9.68	6.78	41%	177%	102	6.75	41%	176%	101
Athlete F	10.11	5.24	15	82%	139	9.25	6.47	25%	124%	97	7.24	41%	138%	109

Table 11. Using 40-50% ASR rule for extensive tempo prescription (15 sec intervals)

And here is a table for 100m tempo intervals:

							70% Velocity				50% ASR			
Athlete	MSS	MAS	Time	%ASR	Distance	Avg Velocity	Velocity	%ASR	%MAS	Time	Velocity	%ASR	%MAS	Time
Athlete A	9.00	4.44	12.00	85%	100	8.33	5.83	31%	131%	17.14	6.39	43%	144%	15.66
Athlete B	10.00	3.75	10.90	87%	100	9.17	6.42	43%	171%	15.57	6.46	43%	172%	15.47
Athlete C	9.09	4.64	11.85	85%	100	8.44	5.91	28%	127%	16.93	6.54	43%	141%	15.29
Athlete D	10.54	3.70	10.35	87%	100	9.66	6.76	45%	183%	14.79	6.68	44%	181%	14.97
Athlete E	10.94	3.83	9.90	88%	100	10.10	7.07	46%	185%	14.14	6.97	44%	182%	14.36
Athlete F	10.11	5.24	10.55	87%	100	9.48	6.64	29%	127%	15.07	7.36	44%	140%	13.59

Table 12. Using 40-50% ASR rule for extensive tempo prescription (100m intervals)

As can be seen from two tables above, some athletes did tempo slightly faster or slightly slower when comparing different methods of ***individualization*** (70% of average velocity, or 40-50% of %ASR needed). Whichever method you decide to use, HIT Builder can do it for you.

For the reasons already outlined, it is easier to prescribe tempo using time, because in that case, %ASR for tempo is always the same (see table below):

Time	%ASR max	40-50% %ASR
10	88%	35-44%
15	82%	33-41%
20	77%	31-39%
30	68%	27-34%
45	56%	22-28%

Table 13. Prescribing extensive tempo using time and 40-50% ASR rule

With the distance, the %ASR changes based on athletes' individual MAS and MSS, so it is important to use HIT Builder (Tempo Builder (distance) tab).

HIT Name		Work Interval				Rest Interval			Set information			
		Duration	MAS	IFT	ASR	Duration	MAS	IFT	W:R	Format	# of Sets	Rest btwn sets
Tempo Strides												
Time	**10:30**	10sec	*135-145%*	115-125%	35-44%	30sec	passive		1:3	10-15min	2-5 sets	3-5min
	15:45	15sec	*130-140%*	110-120%	33-41%	45sec	passive		1:3	10-15min	2-5 sets	3-5min
	20:60	20sec	*130-140%*	105-115%	31-39%	60sec	passive		1:3	10-15min	2-5 sets	3-5min
	30:90	30sec	*125-135%*	102.5-110%	27-34%	90sec	passive		1:3	10-15min	2-5 sets	3-5min
	45:135	45sec	*120-130%*	100-105%	22-28%	135sec	passive		1:3	10-15min	2-5 sets	3-5min
	60:180	60sec	*115-125%*	95-102.5%	18-23%	180sec	passive		1:3	10-15min	2-5 sets	3-5min
Dist	**100m**						passive		1:3	10-15min	2-5 sets	3-5min
	200m						passive		1:3	10-15min	2-5 sets	3-5min
	300m						passive		1:3	10-15min	2-5 sets	3-5min
	400m						passive		1:3	10-15min	2-5 sets	3-5min

Table 14. Extensive tempo HIT drills

In the case of using %ASR to prescribe tempo work, make sure to use 1-1.5 seconds start loss correction.

Interlude on *individualization*

Hopefully by now you have realized that individualization of training prescription and hence training load is tricky and complex. As shown in tempo prescription, one can use 70% of the best time, or use 40-50 %ASR. Which one is better? I'm not sure, especially because we need to take into account that these intervals are repeated for certain number of reps and how fast the athletes recover in between. We just assume that by individualizing (in this case using percent of max) we create a hypothetical ***equal playing field*** (in terms of stress or training load).

What does an equal playing field actually mean? It means that each athlete works according to their potential (or their maximum). But here is the kicker - how do we measure their potential (or their maximum)? We can use %ASR, but that works for intervals over 110-120% MAS; it doesn't work for long slow distance. We could use MAS, Power, vLT, vGET, VO_2 or percent of velocity. But on top of these, there are numerous other factors we haven't considered (bodyweight, height, recoverability, you name it). On top of this, add normal day-to-day variability in athletes' performance, adaptation, mood, stress levels, willingness to train, nutrition, sleep and so forth, and we are completely lost.

Even if we manage to achieve working at the same relative potential, is that enough to make someone adapt and improve? Does doing intervals at 55% ASR for 20 minutes represent the same stimuli for Athlete A and B? It is indeed a step forward from doing 100s in 16seconds for everyone on the squad, but even with this individualization we are far from ***real individualization***. The question is, should we even bother and can we even achieve it? Or more importantly - is it counterproductive? To create an equal playing field we would need to be able to ***predict*** things, but we can't. We need to embrace the uncertainty. And we need certain strategies that are ***robust***, rather than optimal, when dealing with such uncertainties. Luckily enough, there are a few that are going to be covered in the planning chapter.

This all reminds me of the social justice warrior (SJW) types who are trying to create an equal playing field (whatever the heck it means), but are actually creating havoc and chaos. An equal playing field is a pipe dream - you try to equalize for one thing and create chaos and terror for the others. Equal pays for everyone? Yes, this resulted in Gulags.

Similar to training – when trying to ***optimize*** (e.g. create an equal playing field) for one variable, under a given model and its assumptions, you will completely miss other, maybe much more important, things (because they are not part of your model; usually called a 'third variable' or 'missing variable'). Remember the T@VO_2peak? A few lab coats believe it is a stimuli for adaptation in HIT training modalities. Having that as our mind model, we are going to try to optimize (in this case ***maximize***) this metric under the constraints (e.g. time available, stress, etc.). In this case we might completely ditch the tempo HIT variation "because it doesn't maximize T@VO_2max for the time and energy invested." We would have put it in "The Training Gulag."

There are a few things to keep in mind: 1) we all use models, just make sure to realize it and, if possible, try to use multiple models, 2) optimization relies on prediction and certainty; unfortunately, there are numerous sources of uncertainty as we will soon see in the next chapter, and 3) embrace the uncertainty and randomness and don't be an overly confident prick. And most importantly, realize that real individualization, a real equal playing field, is out of reach; Maybe even trying to reach it is counterproductive. But that shouldn't stop us from trying better methods. Just because all models are wrong, it doesn't mean that a few are not useful (but some are harmful, to paraphrase Nassim Taleb (Taleb, 2007; 2014).

It is important to note that endurance athletes in Track & Field usually don't use MAS or vLT, vGET, and so forth to prescribe training, but rather they use actual running performance over a certain distance (Magness, 2013). Understanding the above constructs is important (as well as physiology and biomechanics), but it is not enough for endurance athletes - they do need more precision. In a way, they use a more **phenomenological approach** of using what they can directly measure, experience and observe (e.g. time trials, velocities, etc.).

Phenomenology is a philosophical movement founded in the early years of the 20th century by Edmund Husserl. In this manual, a phenomenological approach refers to describing phenomena as they are experienced or as they appear to the observer, without further complicated analysis. For example, a soccer coach might define *strength in the duel* as a quality certain athletes possess only by observing how they solve duel contacts without any biomechanical analysis.

So rather than trying to improve certain, underlying constructs ("We need to improve your MAS") and focusing on being inside the "MAS Zone," endurance athletes work to improve a specific ***phenomenological quality*** ("Working on your final kick in 5k"). Even with using such an approach, individualization is hard because how do we know if we should use 90% or 80% of their best performance? Or strip 4 seconds, or 10 seconds? Or repeat 10 intervals or 15 intervals? How do we juggle all of this when training a group of athletes?

With team sport athletes things are a bit more general, since we do not have a specific distance to cover and to be evaluated on. But it is also foolish to state that the sole objective of HIT is to increase MAS or any other underlying construct, although they are more than ***satisficing*** for designing the HIT. There are also other viable objectives and understanding them and combining them with the sport/skill practices will allow you greater flexibility and power in designing HIT drills.

Short Intervals format

Short intervals are usually done in sets of 4-8 minutes, repeated 2-6 times, with 3-5 minutes of passive or active rest in between. These are of course rules of thumb and something you can modify based on your context and objectives.

When it comes to tempo, it is usually done for 10-15 minutes per set, for about 2-5 times. In the case of using distance instead of time, one set usually involves 4-6 intervals (e.g. 100+100+100+200+100), repeated 2-5 times (Hansen, 2014).

Progression with Short Intervals

Similar to long intervals, short intervals can have the following progression:

1. Increase overall duration by increasing the number of repetitions in a set (e.g. from 5min of 15:15 to 6min of 15:15)
2. Increase overall duration by increasing the number of sets (e.g. from 2x8min of 30:30 to 3x6min of 30:30)
3. Decrease the recovery time between intervals (e.g. from 30sec work 30sec rest, to 30sec work to 20sec rest)
4. Extend the duration of the work interval (e.g. from 15sec work 15sec rest, to 20sec work 15sec rest)

5. Increase the intensity in the active recovery phase (e.g. from 45% to 55%)
6. Increase the intensity of the work interval (e.g. from 100% to 105% MAS)

It is important to understand that ***variations*** and ***progressions*** are not easily distinguishable. For example, you can look at 30:30 as a progression from 20:20 (because 30sec is longer than 20sec), or vice versa (because 20s intervals can be done at a higher %MAS or %ASR). Thus, progression should be seen as making things harder ***within*** a given HIT variation (e.g. extending 20sec in 20:20 to 25 seconds at 120% MAS).

	Athlete A (20:20 at 110% MAS)		
	Duration	MAS	Distance
Phase #1	18:20	4.44	88
	20:20	4.44	98
	22:20	4.44	107
	24:20	4.44	117
Phase #2	18:20	4.58	91
	20:20	4.58	101
	22:20	4.58	111
	25:20	4.58	121

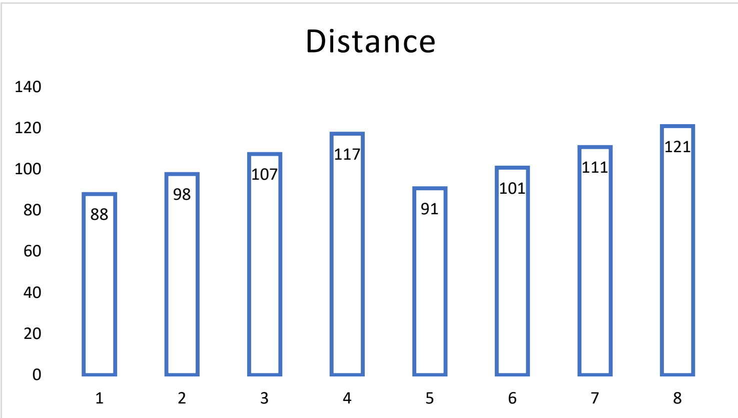


Figure 33. Waving effect of increasing MAS between two phases of HIT conditioning

I also suggest creating progression cycles and then repeating them in iterations. Let's assume that we plan on doing 20:20 at 110% MAS and we are going to progress the work interval from 18, 20, 22 to 24 seconds over a few workouts. For this example, I am going to use Athlete A again (MAS 4.44 m/s, MSS 9 m/s).

After the athletes finish one phase, MAS can be retested or increased by 0.07m/s to 0.14m/s (0.25-0.5km/h) and then the phase can be repeated in a "rinse and repeat" type of way. This way we get long term progression, we slowly cook the athletes and get this nice implicit ***zig-zag*** (wave) pattern without the need to plan it explicitly.

Sprint Interval Training (SIT)

Sprint interval training is, more or less, sprinting ***all-out*** for more than 15-20 seconds. Some coaches call it ***lactate production*** or ***lactate tolerance*** training, but I don't prefer to name certain methods based on an assumed mechanism or process involved, but rather based on phenomenological characteristics of the training itself. In Track & Field circles, these methods are usually called ***specific endurance*** or ***intensive tempo***, but the terminology differs a lot because the objectives of these workouts differ between coaches.

When it comes to HIT, sprint interval training (SIT) can be classified in intensive and extensive variations.

HIT Name		Work Interval				Rest Interval			Set information			
		Duration	MAS	IFT	ASR	Duration	MAS	IFT	W:R	Format	# of Sets	Rest btwn sets
Sprint Interval Training (SIT)												
Int	**15sec**	15sec	all-out	all-out	77-82%	>2min	pass/act		1:6-8+	3-8 reps	1-3 sets	5-10 min
	20sec	20sec	all-out	all-out	72-77%	>2min	pass/act		1:6-8+	3-8 reps	1-3 sets	5-10 min
	30sec	30sec	all-out	all-out	63-68%	>3min	pass/act		1:6-8+	3-6 reps	1-3 sets	5-10 min
	45sec	45sec	all-out	all-out	51-56%	>4min	pass/act		1:6-8+	3-6 reps	1-3 sets	5-10 min
Ext	**15sec**	15sec	sub-max	sub-max	54-66%	<2min	pass/act		1:4-6-	5-12 reps	1-4 sets	4-6min
	20sec	20sec	sub-max	sub-max	50-62%	<2min	pass/act		1:4-6-	5-12 reps	1-4 sets	4-6min
	30sec	30sec	sub-max	sub-max	44-54%	<3min	pass/act		1:4-6-	5-10 reps	1-4 sets	5-7min
	45sec	45sec	sub-max	sub-max	36-45%	<4min	pass/act		1:4-6-	5-10 reps	1-4 sets	5-7min

Table 15. Sprint Interval Training (SIT)

Intensive sprint interval training (Intensive SIT)

Intensive SIT is truly an ***all-out*** sprint, done for 15-20+ seconds (up to 45, or even longer) with almost complete recovery in between. In Track & Field circles this type of workout is usually called ***specific endurance***, but it is done with full recovery between repetitions, which involves resting for 30-90sec per second of activity (e.g. 15sec all-out SIT would involve 8min to 22minutes of rest, which is 1:30 to 1:90

work-to-rest ratio). This is because the goals of a sprinter differ from the goals of HIT conditioning. In the latter case, the rest is substantially shorter, usually around 2-6 minutes (depending on the duration of the sprint) and the work-to-rest ratio is around 1:6 to 1:8 or more. Having said this, it is important to expect a drop in performance across repetitions, so using %ASR to prescribe beyond the first sprint could be too optimistic and hence problematic.

For this reason, take the suggested %ASR as solely a starting point and not something that should be held strictly. In a way, using distance instead of time in intensive SIT can work well - e.g. using the HIT Builder (Tempo Builder (Distance tab)) to calculate the initial distance for 20 seconds. Then repeat that distance ***all-out*** and allow for time to extend as fatigue sets in. It is the art of coaching to figure out how much fatigue we want to accumulate and what should be the allowed % drop (e.g. if that 20sec extends to 25 seconds we should probably call it a day; Track & Field coaches would call it a day much earlier though, but they have complete rest between reps).

Using our six athletes as examples, here is how the workout can be planned. We decide to do 20sec intensive SIT. Here are the distances assuming a flying start (without start loss correction):

Athlete	MSS	MAS	Distance
Athlete 1	9.00	4.44	159
Athlete 2	10.00	3.75	171
Athlete 3	9.09	4.64	161
Athlete 4	10.54	3.70	179
Athlete 5	10.94	3.83	186
Athlete 6	10.11	5.24	180

Table 16. Calculated distances for 20-sec SIT HIT drills based off athletes' MSS and MAS (assumes flying start)

One thing to keep in mind is to use ***start loss*** correction and start conservatively with distance (better to go under for 20% than over for 5% - ***asymmetry*** as Nassim Taleb would call it (Taleb, 2014)). Besides, team sport athletes are not used to this type of training and it can easily wreak havoc (e.g. sore or pulled hamstrings, calves or quads) (Buchheit & Laursen, 2013a). The solution might be to do this in shuttles with COD, to avoid building up the speed too much (gassers anyone? Or 150-300 yard shuttles?). In this case, you can use the HIT Builder to help you estimate the distances, but always use your intuition here and adjust as you see fit.

In the above case, you can prescribe time zones, e.g. from 21 to 23 seconds across repetitions (I have added 1 second start loss, although more can be added) for everyone to follow.

Another approach would be to prescribe the same distance for everyone and assign times to groups. Let's say 200m:

Athlete	MSS	MAS	Time
Athlete 1	9.00	4.44	26.0
Athlete 2	10.00	3.75	24.0
Athlete 3	9.09	4.64	25.5
Athlete 4	10.54	3.70	22.8
Athlete 5	10.94	3.83	21.8
Athlete 6	10.11	5.24	22.5

Table 17. Calculated times for 200m SIT HIT drills based off athletes' MSS and MAS (assumes flying start)

Putting the lads on the same line can cause competition between them and that is always good to increase motivation and hence effort (especially in ***all-out*** intervals). So from this viewpoint, prescribing distance rather than time and allowing everyone to compete can be a nice ***trick*** to milk-out maximal effort and make it more fun (which are not factors of low importance, ***au contraire***). Each group can have a time zone they should strive for, otherwise they just might slack (although slacking sometimes can be due to day-to-day variation and mood, not only because someone is being a slacker; again, the importance of art rather than numerical science).

Here is the table for %ASR for the first repetition of the intensive SIT intervals when prescribed using time (added 5% margin of error).

SIT Duration	%ASR
15sec	77-82%
20sec	72-77%
30sec	63-68%
45sec	51-56%

Table 18. Associated %ASR with SIT of different durations

Some coaches prefer to do hill sprints (me too) and in that case, the HIT Builder should be used only as a rough estimate. But in my experience, coaches usually prescribe the same distance to everyone for the hill workout and instruct them to run all-out. In this case, the 'equal playing field' is lost, but we allowed for some ***self-regulation*** of the athletes. Assuming the athletes can be trusted to give a good effort, there is no need to specially prescribe time or distance and make things more complex then they need to be. If all your HIT drills are strictly prescribed and directed by you, "The Hitler Coach," then maybe some HIT drills should be left to the athletes to self-regulate, especially the ***all-out*** intervals, which are really hard to predict from rep to rep, day to day.

Long story short, when using intensive SIT, prescribe using distance for everyone so the competition can happen, try to do intervals in shuttles (e.g. 6x40m), get a ball-park estimate of where athletes should be in terms of their time using HIT Builder, but allow for time zones and accept certain drops in performance across repetitions.

Extensive sprint interval training (extensive SIT)

Extensive SIT is something that Track & Field coaches tend to call ***intensive tempo***, which is quite similar to ***extensive tempo*** that we already covered. Extensive tempo, as we have discussed already, is usually performed at 70% or less of mean velocity for a 100-200m distance. Intensive tempo is around 80-90% of mean velocity. Extensive SIT is slightly less all-out than intensive SIT, which allows for shorter rest and/or longer repetitions. The work-to-rest ratio is 1:4-6 or lower (as opposed to 1:6-8 or higher in intensive SIT), hence the rest is incomplete and the fatigue over reps will set in.

Using similar logic as with tempo HIT, extensive SIT can be calculated using either 80-90% of the mean velocity of the distance or 70-80% of %ASR for a given distance/time. The table below contains recommendations for extensive SIT using time prescription and 70-80% of %ASR:

Duration	Intensive SIT %ASR	Extensive SIT %ASR
15sec	77-82%	54-66%
20sec	72-77%	50-62%
30sec	63-68%	44-54%
45sec	51-56%	36-45%

Table 19. Prescribing extensive SIT using 70-80% ASR rule of thumb

Both approaches of extensive SIT prescription can be done using the Tempo Builder tab in the HIT Builder. It is important to note that due to fatigue accumulation, repetition distance and time will get progressively worse. In this regard, the ASR values from the table represent only starting values. With extensive SIT, the organization should be more strict as opposed to intensive SIT because we do not want athletes to race each other. It would be wise to create groups of specific distances that need to be covered or time over a pre-defined distance, as well as to allow for some performance decrement over the reps.

Organization-wise, the easiest way would be to prescribe a shuttle-based or straight line distance for everyone and then assign times to groups of similar characteristics. Because the times between repetitions are long, each group can go separately and hit their own prescribed time. For example, in the picture below we have 4x60m extensive SIT, done with 1sec start loss correction and 0.7 COD loss correction at 85% of the velocity for that distance. Athletes are placed into 3 groups, each starting on their own and having a designated time. While waiting, others can perform some easy technical drills or some prehab or core movement.

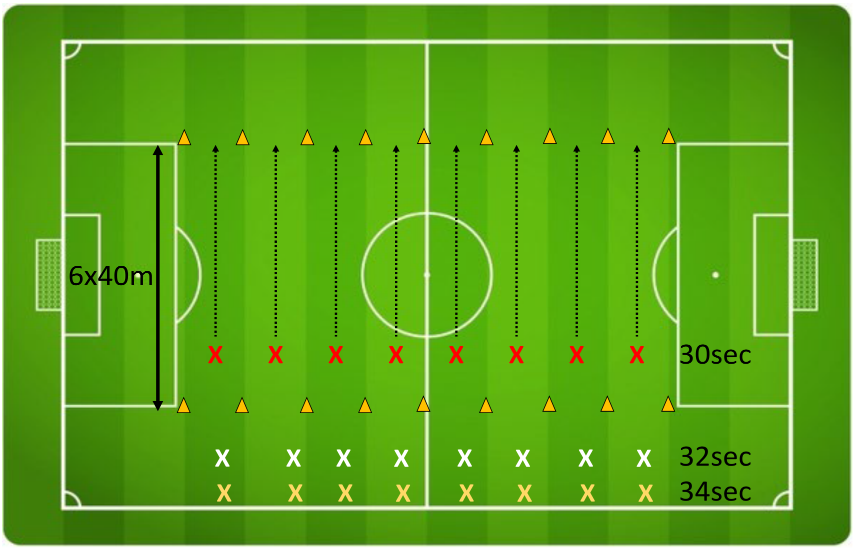


Figure 34. Organizing extensive SIT for group of athletes

Setup above can also work for intensive SIT, although an "all-out" command can be given and athletes can be setup in groups of similar ability as well to allow for closer competition between them. Some playful game can be done, e.g. collecting points in each group and losers from groups need to pick up the cones.

Sprint Interval Training format

Sprint intervals are done for a short number of reps (e.g. 3-5) over one or more sets (1 to 3 sets). The recovery between reps and between sets can be active or passive. If combined with team practice, easy technique drills can be performed in between reps and sets, or even better, the sets can be distributed across training practice rather than done in one block (e.g. 4 SIT intervals, small-sided game, 4 SIT intervals, small-sided game, 4 SIT intervals). The duration of the rest between sets is longer, around 10 or more minutes.

You can also play with decreasing or increasing the number of intervals in a set (4,3,2 or 2,3,4), or decreasing or increasing the rest between intervals (3min, 2.5min, 2min vs 2min, 2.5min, 3min). This can also be a mental challenge and game, to suck it up as it gets more difficult. As outlined before, the objectives of HIT goes beyond improving VO_2peak or MAS scores.

Sprint Interval Training progression

When it comes to SIT, there is not much variation since every rep is done all out. Progression wise, one could start with shorter reps and extend them to longer ones (e.g. from 20sec to 40sec), and if you are working with team sport athletes, doing SIT in a shuttle arrangement and then moving to straight lines can be a viable strategy.

Here are few heuristics to use:

1. Start with shorter intervals (e.g. 20 sec) and progress to longer (e.g. 40sec)
2. Start with extensive SIT before going “balls to the wall” with intensive variations
3. With team sport athletes, start with shorter shuttles (e.g. 20m) and progress to longer (e.g. 40-60m), eventually going to straight lines
4. Increase the number of intervals before extending the duration of the intervals
5. Once a certain amount of reps has been achieved, decrease the rest
6. You can also use a “linear” strategy of starting with longer intervals, using extensive SIT (e.g. 40-60sec), and progressing to shorter, more intensive SIT (e.g. 20-30sec)

These progressions can be made over a longer period of time, especially since I do not recommend doing SIT frequently, for a long duration, or with a huge volume.

Repeat Sprint Training (RST)

Repeat sprint training involves shorter sprints (e.g. 2-8 seconds) performed with shorter rest in between (less than 20seconds) for 6-10 or more repetitions (Bishop, Girard, & Mendez-Villanueva, 2011; Buchheit & Laursen, 2013a; 2013b; Girard, Mendez-Villanueva, & Bishop, 2011). A lot of coaches consider RST the gold standard for conditioning in team sports since it represents how the athletes play the game. Funny enough, studies didn't find many ***repeat sprint sequences*** (RSS) in the game itself, at least in soccer (Carling, Le Gall, & Dupont, 2012; Gabbett & Mulvey, 2008). But it would be unwise to ditch RST because RSS only happens a few times on average in the game. We want our athletes to be prepared for the ***worst case scenario*** and not only for the ***average scenario***. For that reason RST is important, but similar to SIT, it shouldn't be overdone.

The aim (at least from a simplistic and reductionist point of view) of RST is to improve ***repeat sprint ability*** (RSA). As the name says, RSA is the ability to repeat sprints with short rest, without much decrement in performance (Bishop et al., 2011; Girard et al., 2011). There are multiple ways to express RSA (some have better or worse reliability, but most have shitty reliability with more than 30% CV), and it mostly revolves around total time (sum of all sprints) and ***percent decrement*** (which is equal to ***100 x (total time / (best time x number of sprints)) - 1)*** metrics (Bishop et al., 2011; Girard et al., 2011; Glaister, Howatson, Pattison, & McInnes, 2008). For the sake of example, let's take the scores of two athletes performing 8x40m sprints with 20sec rest:

Sprint	Athlete A	Athlete B
1	4.9	4.5
2	4.92	4.56
3	4.94	4.62
4	4.96	4.68
5	4.98	4.74
6	5	4.8
7	5.02	4.86
8	5.04	4.92
Total Time	39.76	37.68
% Decrement	1.43%	4.67%

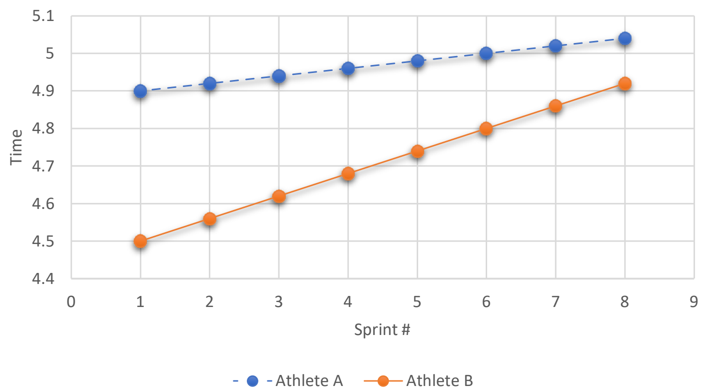


Figure 35. Performance of two athletes performing 8x40m sprints with 20sec rest

Which athlete has better RSA? If you look at % ***Decrement*** as a proxy to RSA, then Athlete A has better RSA. But every single sprint of Athlete B is faster than the first sprint of Athlete A. This can be seen in the ***total tim***e metric. Which one of these athletes would you love to have in your team? This is why it is important how we measure our constructs. In plain English - total time is a better measure of RSA.

What usually happens with our little irrational coaching brains, is as soon as we identify a ***construct*** or a ***quality***, we immediately and fallaciously tend to assume there is a training method that improves that quality. In the case of RSA that is RST (Buchheit, 2012). But hold your horses my reductionist friend. There are a few questions that need to be answered. First, what metric does RST seem to improve? Is it percent decrement or total time? And second, are there any more convenient training methods that achieve the same in less effort?

Don't get me wrong here - I am not against RST (hence the reason to include it in my HIT classification), but I am against its magical properties (and simplistic, reductionist reasoning). The first issue is the reliability of RSA, since it seems that the metrics are not really reliable (in plain English, the results tend to vary from measurement to measurement and that variability could be too big for us to infer training effects; simply: there is more noise than signal) (Glaister et al., 2008). The second issue is that there are multiple ways to measure RSA. And last but not the least, it seems that the single best sprint performance (e.g. I also hypothesize that MSS can work here as well) together with MAS can explain (and predict) RSA performance to an acceptable degree (Buchheit & Mendez-Villanueva, 2014). For those of you not statistically inclined, that means you do not need to measure RSA, since MSS and MAS contain enough of information to predict it and measuring it would be redundant (and torture for the athletes). But just because they ***explain*** RSA, does improving MSS and MAS improve RSA (however expressed) ***better*** (or with less time/energy) than RST (Buchheit, 2012)? What we have here is an example of Hume's guillotine (is/ought dilemma). Well, I can't wait for the research, so I need to act in uncertainty (and **Agile Periodization** is a way to deal with those uncertain things). It seems, as will be explained in the planning chapter, the best strategy would be to perform multiple HIT conditioning options (Bishop et al., 2011; Buchheit, 2012; Buchheit & Mendez-Villanueva, 2014; Girard et al., 2011).

I am not confident enough to put RST into "The Training Gulag," because I am aware that this type of causal inference is based on a simplistic mental model that RST improves RSA and RSA is not that important. But there might be other important things lurking as potential objectives of RST, beyond improving RSA. For example, RST can be combined with a technical and tactical session to create overload or a ***differential learning environment***. It could also be a way to kill two birds with one stone - maintain conditioning and speed stimuli when we are really constrained for time. Or maybe creating a worst case scenario for the athletes. What I am trying to do here is to avoid the traps of ***optimizing*** training because of the uncertainties involved. "***It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.***" If I proclaim that I am not doing RST, I might be throwing the baby out with the bathwater.

The following table contains starting prescription parameters for RST:

HIT Name	Work Interval				Rest Interval			Set information			
	Duration	MAS	IFT	ASR	Duration	MAS	IFT	W:R	Format	# of Sets	Rest btwn sets
Repeat Sprint Training (RST)											
2sec	2sec	all-out	all-out	92-97%	<20sec	pass/act		1:10-	6-10 reps	2-4sets	5-10min
4sec	4sec	all-out	all-out	90-95%	<20sec	pass/act		1:5-	6-10 reps	2-4sets	5-10min
6sec	6sec	all-out	all-out	87-92%	<20sec	pass/act		1:4-	6-10 reps	2-5set	5-10min
8sec	8sec	all-out	all-out	85-90%	<20sec	pass/act		1:3-	6-10 reps	2-4sets	5-10min

Table 20. Repeat Sprint Training (RST)

Similar to SIT, one can perform RST in a straight line manner or in shuttles. Combining it with technical or tactical tasks can also be useful (if not motivating), as well as creating some type of competition between athletes (which is always good in all-out efforts). One solution could be relays, where a few groups can compete and hence create a great atmosphere. One can easily put CODs inside, as well as some technical elements and so forth, but more about this later. To make competition more 'dramatic', equalize the groups using HIT Builder (e.g. distribute into groups so the mean of each group is similar).

On the following picture, there is an example of a relay race where each athlete should sprint down and back 6 times. The last to finish does 20 push-ups, or whatever the athletes agree to be the punishment.

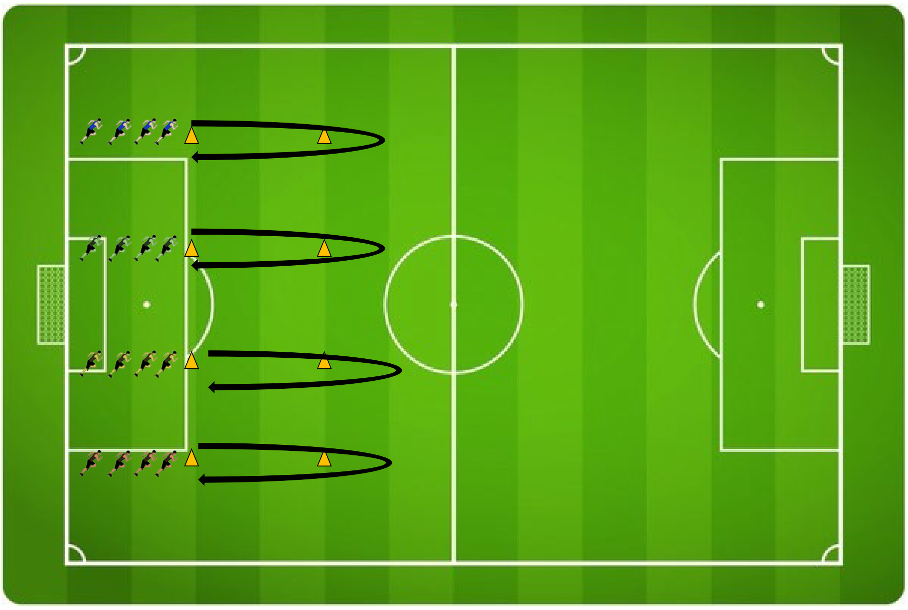


Figure 36. Repeat Sprint Training using relays

Repeat Sprint Training format

The training format for RST revolves around short sprints (e.g. 2 to 8 seconds), short rest (less than 20 sec), and plenty of repetitions (6-10 or even more) performed using 2-4 sets with a 5-10 minute break.

Repeat Sprint Training progression

Similar to sprint interval training (SIT), the progression can happen by making:

1. More total intervals (from 6 sprints to 8 sprints)
2. Decreasing rest between intervals (e.g. from 25 to 20 sec)
3. Extending the duration or length of the sprint (from 4 sec to 6 sec)
4. Performing it in straight line, as opposed to shuttles
5. Introducing technical or tactical elements

Intermittent Recovery (IR)

Intermittent recovery is an easier method of short intervals (usually passive) that is great for introducing athletes (or the general population) to HIT conditioning. Besides, it can be a more *specific* active recovery modality.

HIT Name	Work Interval				Rest Interval			Set information			
	Duration	MAS	IFT	ASR	Duration	MAS	IFT	W:R	Format	# of Sets	Rest btwn sets
Intermittent Recovery (IR)											
10sec	10sec	100-110%		0-10%	20sec	pass/act		1:2	10-15min	2-5 sets	3-5min
15sec	15sec	95-105%			30sec	pass/act		1:2	10-15min	2-5 sets	3-5min
20sec	20sec	90-100%			40sec	pass/act		1:2	10-15min	2-5 sets	3-5min
30sec	30sec	85-95%			60sec	pass/act		1:2	10-15min	2-5 sets	3-5min

Table 21. Intermittent Recovery (IR)

In soccer, we tend to do some type of active recovery on the day after the match. Usually that was 20min of jogging and football-tennis. But the athletes were running like a bunch of Quasimodos, so I decided to try an intermittent version. We did self-paced 50-100m strides with a 50m walk for two sets of 6-12 minutes. The goal was to be loose, but run with proper form. It was also a great way to check if everything was OK in the body (because some nagging issues can be left unspotted with very low intensity running or passive rest).

You can be really creative with intermittent recovery, as long as it is easy. There is no point of being strict with the progressions, tempos, distances and so forth. If there is only one day on which you are not acting like a "Hitler Coach," let it be this one. Let the athletes self-select the pace.

Other modalities

Other modalities might include cycling, rowing, elliptical, battling ropes, punching bag, swimming, running in the water, you name it. All of these can be performed of course, just follow the relative level of the effort as well as work and rest durations. Dan Baker wrote a great article regarding non-running HIT options (Baker, 2012). The exact calculation of ASR and predicting performance on different modalities (besides running) is beyond this manual and probably represents an exercise in futility since such complexity is most likely not needed in the real world. If you are a cyclist or rower then it definitely is and for that reason you can use this manual to get few ideas, but in my mind your focus as an endurance athlete should be your competition distance and other phenomenological qualities, rather than improvement of some constructs (such as MAS), or using MAS to prescribe your workouts. It could be still viable to understand the relationship between these constructs as well as ASR (although you need to know your specific factor ***k***, which is 0.013 for running, and 0.026 for cycling (Bundle & Weyand, 2012; Weyand, 2005))

Adding extra elements

It would be easy to add extra elements on top of HIT conditioning. These elements might involve:

- Jumps before or after the interval (or even on CODs),
- Lay downs on COD (useful in rugby), so each run would start from the ground (make sure to add some extra time loss per COD),
- Adding polygon elements (e.g. zig-zag poles, or other obstacles),
- Technical elements on COD or after the finish of the interval (e.g. pass or shoot at the goal, for example, doing SIT or RST with repeated shooting at the goal),
- Tactical and decision making elements, for example, RST with 1v1 situation

I will leave it to your coaching imagination to come up with variations of HIT conditioning that suit your session objectives and context. Just make sure to adjust the predicted times from HIT Builder, which you should use as an educated guess, but trust your coaching instinct and subjectivity more.

One might complain that adding technical or tactical elements decreases the ***overload*** that HIT drills induce. I do not see this as a drawback (as long as both combinations are performed, more or less), but rather as a needed blend between skill acquisition and sharpening, together with loading the physical aspects. It is our mental and inferential models that need updating in this case, since ***endurance*** in team sports is not solely the MAS level, but rather an athlete's ability to continuously, with high frequency and without a drop in quality, read the game situations, interact with other players, make decisions, and convey technical elements with effectiveness and efficiency. Looking at it from this viewpoint, performing conditioning using technical and tactical combinations is of high importance.

We tend to have (being aware of it or not) this dichotomist model of performance that consists of underlying intrinsic potential (e.g. MAS, MSS and you name it) and expressed performance (skill, or ability to use this potential). This is quite similar to substance vs. form dichotomy in philosophy:

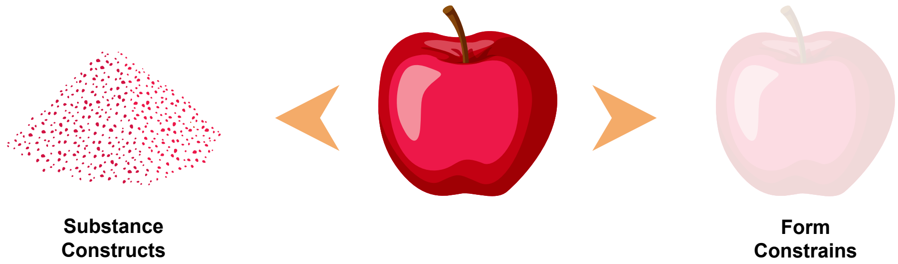


Figure 37. Substance vs. Form, or Potential vs. Realization.
(Image modified based on Dichotomistic website. Available at http://www.dichotomistic.com/)

In the case of performance, we simplify things to underlying motor abilities (substance, constructs), that need to be addressed for the performance (form) to emerge. Using this reductionist model and its assumptions, we believe that by directly hitting (with specialized methods) certain constructs (e.g. MAS, vGET, LT, MSS), our performance will immediately improve. Thus, we believe that all constructs have assigned training methods and intensity zones that hit them, for example as RSA has RST, MAS has HIT, vGET has threshold training and so forth. But there are multiple fallacies here and we are lucky to witness the embracement of more complex models that acknowledge the interconnection between substance and form, or between performance constructs (i.e. biomotor abilities) and skillful performance. As strength and conditioning coaches, we need to break this chasm. For this reason, combining an ***analytical*** approach of reducing performance to simplistic constructs with a more ***complex*** approach that acknowledges ***phenomenological*** aspects of performance is the way to go, if you ask me. So there's nothing wrong with combining HIT with skill practices to create constraints that allow for the emergence of skillful performance. The objective of training is to improve competitive performance rather than solely improving constructs (although that is still a viable goal). Embrace the complementary approach.

HIT Name		Work Interval				Rest Interval			Set information			
		Duration	MAS	IFT	ASR	Duration	MAS	IFT	W:R	Format	# of Sets	Rest btwn sets
Passive Long Intervals (PLI)												
Int	**1':2'**	60sec	100-110%	*85-95%*	*0-10%*	120sec	passive		1:2	10-15 x 1min	1-2sets	3-5min
	1'30':3'	90sec	100-110%	*85-95%*	*0-10%*	180sec	passive		1:2	8-12 x 90sec	1-2sets	3-5min
	2':4'	120sec	100-110%	*85-95%*	*0-10%*	240sec	passive		1:2	6-10 x 2min	1-2sets	4-6min
	3':6'	180sec	100-110%	*85-95%*	*0-10%*	360sec	passive		1:2	5-8 x 3min	1-2sets	5-7min
Norm	**1':1'**	60sec	95-105%	*80-90%*		60sec	passive		1:1	10-15 x 1min	1-2sets	3-5min
	1'30':1'30	90sec	95-105%	*80-90%*		90sec	passive		1:1	8-12 x 90sec	1-2sets	3-5min
	2':2'	120sec	95-105%	*80-90%*		120sec	passive		1:1	6-10 x 2min	1-2sets	4-6min
	3':3'	180sec	95-105%	*80-90%*		120sec	passive		1:1	5-8 x 3min	1-2sets	5-7min
Ext	**1':30''**	60sec	90-100%	*75-85%*		30sec	passive		2:1	10-15 x 1min	1-2sets	3-5min
	1'30:45''	90sec	90-100%	*75-85%*		45sec	passive		2:1	8-12 x 90sec	1-2sets	3-5min
	2':1'	120sec	90-100%	*75-85%*		60sec	passive		2:1	6-10 x 2min	1-2sets	4-6min
	3':1'30	180sec	90-100%	*75-85%*		90sec	passive		2:1	5-8 x 3min	1-2sets	5-7min
Active Long Intervals (ALI)												
Int	**1':2'**	60sec	90-100%	*75-85%*		120sec	60-70%	*50-60%*	1:2	10-15 x 1min	1-2sets	3-5min
	1'30':3'	90sec	90-100%	*75-85%*		180sec	60-70%	*50-60%*	1:2	8-12 x 90sec	1-2sets	3-5min
	2':4'	120sec	90-100%	*75-85%*		240sec	60-70%	*50-60%*	1:2	6-10 x 2min	1-2sets	4-6min
	3':6'	180sec	90-100%	*75-85%*		360sec	60-70%	*50-60%*	1:2	5-8 x 3min	1-2sets	5-7min
Norm	**1':1'**	60sec	85-95%	*70-80%*		60sec	55-65%	*45-55%*	1:1	10-15 x 1min	1-2sets	3-5min
	1'30':1'30	90sec	85-95%	*70-80%*		90sec	55-65%	*45-55%*	1:1	8-12 x 90sec	1-2sets	3-5min
	2':2'	120sec	85-95%	*70-80%*		120sec	55-65%	*45-55%*	1:1	6-10 x 2min	1-2sets	4-6min
	3':3'	180sec	85-95%	*70-80%*		120sec	55-65%	*45-55%*	1:1	5-8 x 3min	1-2sets	5-7min
Ext	**1':30''**	60sec	80-90%	*65-75%*		30sec	50-60%	*40-50%*	2:1	10-15 x 1min	1-2sets	3-5min
	1'30:45''	90sec	80-90%	*65-75%*		45sec	50-60%	*40-50%*	2:1	8-12 x 90sec	1-2sets	3-5min
	2':1'	120sec	80-90%	*65-75%*		60sec	50-60%	*40-50%*	2:1	6-10 x 2min	1-2sets	4-6min
	3':1'30	180sec	80-90%	*65-75%*		90sec	50-60%	*40-50%*	2:1	5-8 x 3min	1-2sets	5-7min
Passive Short Intervals (PSI)												
Int	**10:20**	10sec	*120-130%*	102.5-110%	20-30%	20sec	passive		1:2	4-8min	2-6sets	3-5min
	15:30	15sec	*120-130%*	102.5-110%	20-30%	30sec	passive		1:2	4-8min	2-6sets	3-5min
	20:40	20sec	*120-130%*	102.5-110%	20-30%	40sec	passive		1:2	4-8min	2-6sets	3-5min
	30:60	30sec	*120-130%*	102.5-110%	20-30%	60sec	passive		1:2	4-8min	2-6sets	3-5min
Norm	**10:10**	10sec	*110-120%*	95-102.5%	10-20%	10sec	passive		1:1	4-8min	2-6sets	3-5min
	15:15	15sec	*110-120%*	95-102.5%	10-20%	15sec	passive		1:1	4-8min	2-6sets	3-5min
	20:20	20sec	*110-120%*	95-102.5%	10-20%	20sec	passive		1:1	4-8min	2-6sets	3-5min
	30:30	30sec	*110-120%*	95-102.5%	10-20%	30sec	passive		1:1	4-8min	2-6sets	3-5min
Ext	**10:05**	10sec	100-110%	85-95%	0-10%	5sec	passive		2:1	4-8min	2-6sets	3-5min
	15:07	15sec	100-110%	85-95%	0-10%	7.5sec	passive		2:1	4-8min	2-6sets	3-5min
	20:10	20sec	100-110%	85-95%	0-10%	10sec	passive		2:1	4-8min	2-6sets	3-5min
	30:15	30sec	100-110%	85-95%	0-10%	15sec	passive		2:1	4-8min	2-6sets	3-5min
	30:10	30sec	90-100%	*75-85%*		10sec	passive		3:1	4-8min	2-6sets	3-5min
	45:15	45sec	90-100%	*75-85%*		15sec	passive		3:1	4-8min	2-6sets	3-5min
Active Short Intervals (ASI)												
Int	**10:20**	10sec	*110-120%*	95-102.5%	10-20%	20sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
	15:30	15sec	*110-120%*	95-102.5%	10-20%	30sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
	20:40	20sec	*110-120%*	95-102.5%	10-20%	40sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
	30:60	30sec	*110-120%*	95-102.5%	10-20%	60sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
Norm	**10:10**	10sec	100-110%	85-95%	0-10%	10sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
	15:15	15sec	100-110%	85-95%	0-10%	15sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
	20:20	20sec	100-110%	85-95%	0-10%	20sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
	30:30	30sec	100-110%	85-95%	0-10%	30sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
Ext	**10:05**	10sec	90-100%	*75-85%*		5sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	15:07	15sec	90-100%	*75-85%*		7.5sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	20:10	20sec	90-100%	*75-85%*		10sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	30:15	30sec	90-100%	*75-85%*		15sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	30:10	30sec	80-90%	*65-75%*		10sec	45-55%	*35-45%*	3:1	4-8min	2-6sets	3-5min
	45:15	45sec	80-90%	*65-75%*		15sec	45-55%	*35-45%*	3:1	4-8min	2-6sets	3-5min
Tempo Strides												
Time	**10:30**	10sec	*135-145%*	115-125%	35-44%	30sec	passive		1:3	10-15min	2-5 sets	3-5min
	15:45	15sec	*130-140%*	110-120%	33-41%	45sec	passive		1:3	10-15min	2-5 sets	3-5min
	20:60	20sec	*130-140%*	105-115%	31-39%	60sec	passive		1:3	10-15min	2-5 sets	3-5min
	30:90	30sec	*125-135%*	102.5-110%	27-34%	90sec	passive		1:3	10-15min	2-5 sets	3-5min
	45:135	45sec	*120-130%*	100-105%	22-28%	135sec	passive		1:3	10-15min	2-5 sets	3-5min
	60:180	60sec	*115-125%*	95-102.5%	18-23%	180sec	passive		1:3	10-15min	2-5 sets	3-5min
Dist	**100m**	See Tempo Builder (Distance)					passive		1:3	10-15min	2-5 sets	3-5min
	200m						passive		1:3	10-15min	2-5 sets	3-5min
	300m						passive		1:3	10-15min	2-5 sets	3-5min
	400m						passive		1:3	10-15min	2-5 sets	3-5min
Sprint Interval Training (SIT)												
Int	**15sec**	15sec	all-out	all-out	77-82%	>2min	pass/act		1:6-8+	3-8 reps	1-3 sets	5-10 min
	20sec	20sec	all-out	all-out	72-77%	>2min	pass/act		1:6-8+	3-8 reps	1-3 sets	5-10 min
	30sec	30sec	all-out	all-out	63-68%	>3min	pass/act		1:6-8+	3-6 reps	1-3 sets	5-10 min
	45sec	45sec	all-out	all-out	51-56%	>4min	pass/act		1:6-8+	3-6 reps	1-3 sets	5-10 min
Ext	**15sec**	15sec	sub-max	sub-max	54-66%	<2min	pass/act		1:4-6-	5-12 reps	1-4 sets	4-6min
	20sec	20sec	sub-max	sub-max	50-62%	<2min	pass/act		1:4-6-	5-12 reps	1-4 sets	4-6min
	30sec	30sec	sub-max	sub-max	44-54%	<3min	pass/act		1:4-6-	5-10 reps	1-4 sets	5-7min
	45sec	45sec	sub-max	sub-max	36-45%	<4min	pass/act		1:4-6-	5-10 reps	1-4 sets	5-7min
Repeat Sprint Training (RST)												
	2sec	2sec	all-out	all-out	92-97%	<20sec	pass/act		1:10-	6-10 reps	2-4sets	5-10min
	4sec	4sec	all-out	all-out	90-95%	<20sec	pass/act		1:5-	6-10 reps	2-4sets	5-10min
	6sec	6sec	all-out	all-out	87-92%	<20sec	pass/act		1:4-	6-10 reps	2-5set	5-10min
	8sec	8sec	all-out	all-out	85-90%	<20sec	pass/act		1:3-	6-10 reps	2-4sets	5-10min
Intermittent Recovery (IR)												
	10sec	10sec	100-110%		0-10%	20sec	pass/act		1:2	10-15min	2-5 sets	3-5min
	15sec	15sec	95-105%			30sec	pass/act		1:2	10-15min	2-5 sets	3-5min
	20sec	20sec	90-100%			40sec	pass/act		1:2	10-15min	2-5 sets	3-5min
	30sec	30sec	85-95%			60sec	pass/act		1:2	10-15min	2-5 sets	3-5min

Table 22. HIT Drills

Planning Strategies

All contemporary planning strategies are based on the assumption of ***predictability*** (certainty) and a simplistic causal network.

For an example, assume that your Government gave you a huge budget to create a new factory in addition to promising 200 skilled workers and 10 MBA experts, a safe market for the product and tax deduction. You have 5 years to finish the project. You will certainly approach this project in a ***waterfall*** manner:

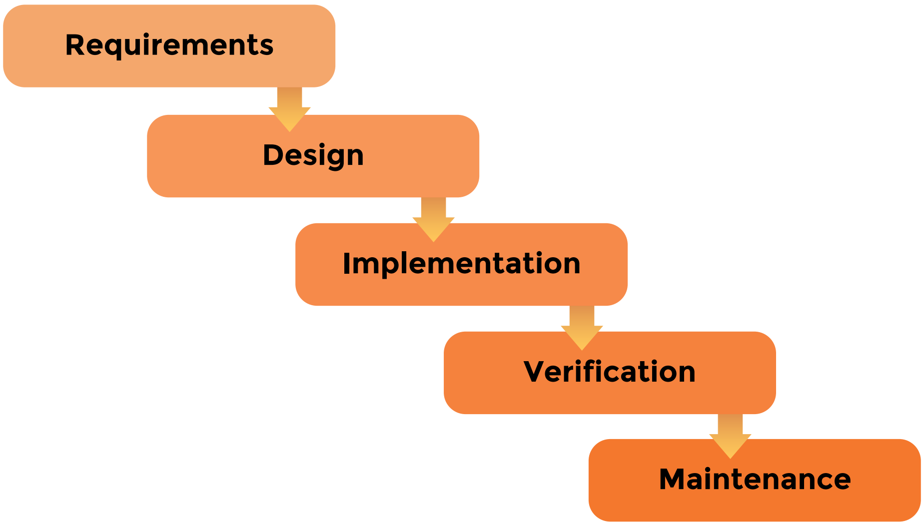


Figure 38. Waterfall project management. Image modified based on SmartSheet website. Available here: https://www.smartsheet.com/agile-vs-scrum-vs-waterfall-vs-kanban

You will spend a few months making plans, acquiring all the needed licenses, creating budgets, and recruiting engineers, and then you will proceed to build things. Later you would equip them and create monitoring tools for workers. Everything in a very discreet, serialized manner.

Let's imagine another scenario. You were recently fired from your job, you have a family to sustain and house mortgage to pay off. You've acquired some life savings and you are willing to invest that into a great new app that you had in mind. How would you approach this project? Will you risk spending all your savings on developing an app for two years that no one will buy or use? Or should you put something on the market as soon as possible, minimize the risk and maximize learning what seems to be interesting to the market? You would develop ***MVP*** (Ries, 2011), minimum viable product, that you would launch and see if your project has any future to start with. This process is outlined in the ***Lean Startup*** methodology (Ries, 2011):

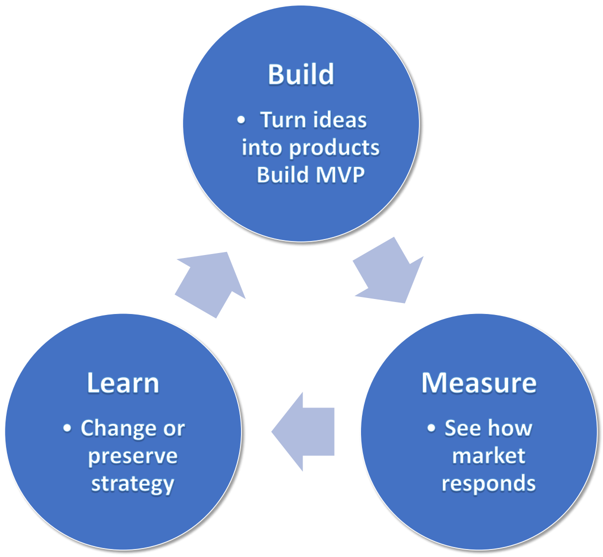


Figure 39. Lean Startup Methodology

What is the difference between the two scenarios above? It is the uncertainty of the second and bounded (constrained) resources. All contemporary planning strategies approach training as it is a factory to be built in a perfectly predictable scenario. The Agile Periodization paradigm I have been developing over the years (and still am) approaches training planning via understanding and embracing the uncertainties and constraints involved (Kiely, 2017; Layton & Ostermiller, 2017; Ries, 2011; Rubin, 2012; Sutherland & Sutherland, 2014).

What uncertainties you might ask? They are plentiful and they all propagate to your day to day decision making as a coach. Luckily, there is huge body of knowledge regarding the most robust decision making within uncertainty (Christian & Griffiths, 2016; Phillips et al., 2017; Gigerenzer, 2004; 2008; 2014; Gigerenzer & Gaissmaier, 2011; Klein, 2017; Mousavi & Gigerenzer, 2014; Neth & Gigerenzer, 2015). But let's quickly cover the involved uncertainties (at least the known ones):

Measurement uncertainties

All performance measures have measurement error issues, which make some more reliable and some less. In plain English, some measure more noise than signal (e.g. RSA measures are not good).

Model uncertainties

Our training models are based on outdated factor analysis models (which are also not exact) and anecdotal evidence that created a ***latent structure*** of motor abilities (constructs). This is very simplistic and needs to be understood as ***satisficing*** heuristics, rather than ontological realities. The underlying causal model of "what causes what" might be very complex and our simplistic reasoning might be especially flawed when working with elite athletes.

The general goal of such an analytic approach is to identify ***limiting factors***, ***rate limiters***, or ***determinants of performance***. But these things are not as easily identifiable in complex human organisms and environments.

For this reason, I believe the way to go is to embrace both the reductionist, analytical approaches as well as the complex, phenomenological approaches. In other words, accept Apollonian and Dionysian approaches, or rational and intuitive, objective and subjective. Complementary.

Chicken or the egg uncertainty

Most constructs and determinants of performance are actually performance derived. For example, we can derive MAS and MSS from two time trials (e.g. 100m and 400m). So stating that improving MAS and MSS improves performance is a bit flawed, since they are actually derived from performance. Stating that improving performance to improve MAS and MSS works the other way around. A friend of mine, an extremely smart lab coat, commented that we cannot say "since a flower grows, the Sun shines," where he alluded that performance changes cannot precede physiological changes (excluding psychological improvements, better pacing, etc.), such as VO_2max (not VO_2peak though). I would tend to agree with this, although not necessarily with the VO_2max notion, since there might be a ***third variable*** that precedes and ***forks*** to cause improvement in both VO_2max/peak and performance (Pearl et al., 2016; Rohrer, 2018).

It is easy to get lost in the philosophy of causality (what causes what and what precedes what). The point to remember is that things are not as clear and certain as the lab coats want us (or themselves) to believe.

Prescription uncertainties

As you can probably see so far, prescription is not an exact science. There are numerous adjusting factors (e.g. start loss, COD loss), numerous ways to prescribe (using MAS, IFT, ASR and many others), numerous modalities (e.g. track, grass, hill, stairs, you name it). Taking this all together, it is too optimistic to assume optimal prescription, but rather ***satisficing*** (good enough) prescription.

Intervention uncertainties

Because we have identified certain constructs and ***determinants*** of performance, we immediately assume that each has its own designated training intensity and training methods that helps improve it and hence improve performance:

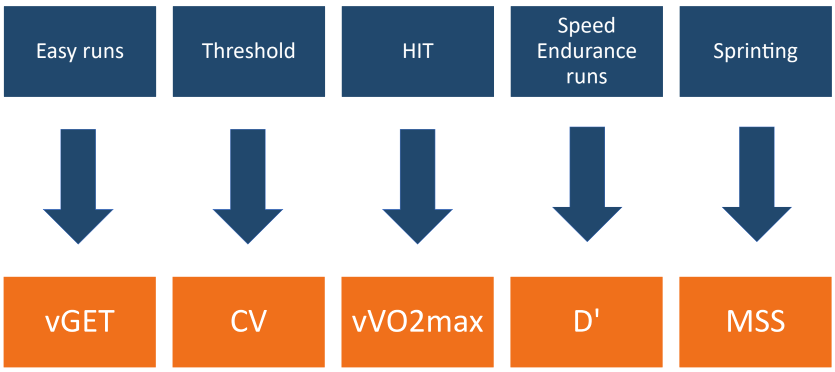


Figure 40. Flawed mental model of methods associated with certain determinants of performance

This is flawed. It is a warm comfort for our certainty and order seeking brains, but it cannot be further from the truth. We do not know in advance what training stimuli cause what adaptation in a single individual. We can get some estimates of what will happen for the average athlete, but not for the particular athlete at hand. This is especially the case when dealing with an elite athlete at the brink of a new world record. For this reason, I despise the term ***evidence-based practice***, especially since it is based on ***garbage-in-garbage-out*** meta-analysis studies on students motivated to get a passing grade. A better term would be ***best practices***, which should come from tinkering in practice, or ***practice-based evidence***. At least it would be more honest and give coaches more realistic expectations.

Individual uncertainties

We tend to believe that by using relative loads (e.g. %MAS, %ASR, %1RM, %PeakPower, etc) in training prescription, we create an e***qual playing field*** where each athlete receives a load relative to his maximum (or potential). This is indeed a step forward from using an absolute prescription for everyone, but it is a SJW's wet dream. There are unlimited metrics we can use to create the same relative load, but even trying to do so is futile. The goal is again ***satisficing***, or finding the ***good enough*** strategy and accepting the uncertainties.

Even with a perfectly equal playing field, the stimuli an athlete might need will differ between individuals. For example, even if relatively expressed, doing 15:15 at 120% MAS for 4 sets of 6 minutes, might be enough for Athlete B to cause adaptation, but too much for Athlete C. Add this to day-to-day variability in athlete readiness and receptiveness to training load and we have a huge amount of uncertainty. We just do not know in advance how someone is going to react to a training stimuli. We do know the expected ***average*** reaction, but we never know how a single individual is going to respond and to what magnitude.

Situation uncertainties

Here we have plenty of uncertainties. A very basic HIT situational uncertainty might be performing runs on grass or on a muddy field in the rain and how will that affect athlete performance, adaptation stimuli and hence, response. The HIT (or any other training for that matter) could be performed during a winning streak or losing streak. The coach and athletes might be under more stress to perform due to losing their last two games. A coach might be under the careful eye of the board and must bring performance to realization soon, so he may be pressured and afraid and his focus will be on short term performance versus long term development. This will affect the training.

Athletes' attendance might be an issue as well. If you plan on doing HIT only on Wednesday and an athlete misses that workout, he or she will miss that type of stimuli for 14 days and the next time he or she does it, it will probably cause more potential issues such as soreness and so forth.

There are indeed many other situational uncertainties that need to be taken into account when creating a training plan. All of the above uncertainties interact and propagate further down the line of decision making. So what should we do? Should we continue pretending that athletes are to be trained the same way a factory should be built and follow the legacy of Fredric's Taylor Scientific Management (Kiely, 2017), or we should embrace the complexities, uncertainties and constraints of both the human organism as well as the context? If so, how?

Luckily for us, there is a great body of knowledge on decision making in uncertainty, starting from the father of the modern Artificial Intelligence (AI) Herbert Simon (whose term ***satisficing*** I have been using from the very start of this manual) up to Gerd Gigerenzer (Christian & Griffiths, 2016; Phillips et al., 2017; Gigerenzer, 2004; 2008; 2014; Gigerenzer & Gaissmaier, 2011; Klein, 2017; Mousavi & Gigerenzer, 2014; Neth & Gigerenzer, 2015) and Nassim Taleb (Taleb, 2007; 2014). What ***Agile Periodization*** aims to achieve is to approach training from the complexity and uncertainty perspective rather than a reductionist biological perspective and apply knowledge from other domains such as the IT industry (e.g. Agile, SCRUM methodologies) and AI (Christian & Griffiths, 2016; Layton & Ostermiller, 2017; Ries, 2011; Rubin, 2012; Sutherland & Sutherland, 2014). What follows are ***Agile Periodization*** principles applied to HIT planning.

Heuristics and Uncertainty

Imagine you have a certain amount of money you want to invest into stocks with the hope of making a profit (and minimizing the risk). In 1990, Harry Markowitz received a Nobel Prize in Economics for his theoretical work on optimal asset allocation, trying to answer the practical question of "How to invest your money in *N* assets." By analyzing historical performance of those assets, Markowitz was able to prove that there is an optimal portfolio that maximizes the return and minimizes the risk. The funny thing is that when Markowitz retired, he didn't use his award winning optimization technique to invest his retirements, but relied on the simple heuristic, ***the 1/N rule***: ''Allocate your money equally to each of N funds.'' (DeMiguel, Garlappi, & Uppal, 2009; Phillips et al., 2017; Gigerenzer, 2004; 2008; 2014; Gigerenzer & Gaissmaier, 2011; Gigerenzer, Todd, ABC Research Group, 1999; Mousavi & Gigerenzer, 2014; Pflug, Pichler, & Wozabal, 2012; Volz, 2012; Neth & Gigerenzer, 2015).

Heuristics, as can be seen from the example above, are simple rules of thumb that disregard a lot of information and they don't try to find the optimal solution, but the satisficing solution (good enough).

There is considerable research that compares the 1/N rule with optimization techniques and the results indicate that optimization techniques are better when fitting to the historical data, but perform worse than 1/N when trying to predict the future. In statistics, there is a concept called ***overfit***, where the model is great at predicting historical data (or data that was used to train the model), but perform miserably when the model is evaluated on the unseen data (DeMiguel et al., 2009; Pflug et al., 2012).

Why did 1/N perform better than the Markowitz asset optimization technique? First of all, for the Markowitz model to work, one needs a great amount of historical data (I might be wrong, but somewhere around 30 years). But the problem is not of ***tractability***, but rather of predictability and robustness. Heuristics are more robust than optimization techniques.

It is important to know in which scenarios heuristics will perform better than optimization techniques. Optimization techniques perform much better at predicting the history (yes, I wrote that correctly - predicting, or retrodicting what already happened) and in situations of predictability. Heuristics perform much better in uncertain situations where one cannot nominate events and calculate their probabilities. Gerd Gigerenzer has done great amount of work in this area and warns about confusing ***risk*** (known unknowns, where we can estimate the probabilities of events) and ***uncertainty*** (unknown unknowns, in which we cannot estimate probabilities). Nassim Taleb calls this the ***ludic fallacy***, or "Life is not a casino!" (Taleb, 2007; 2014).

A similar model is the ***Cynefin Framework*** (Brougham, 2015) by Dave Snowden, that differentiates between five different domains:

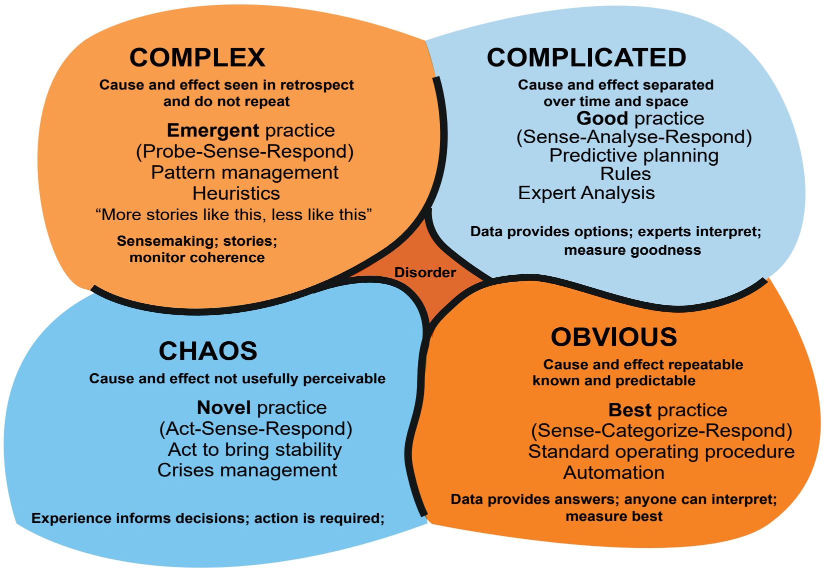


Figure 41. Cynefin framework. Image modified based on https://www.automationjournal.org/tag/cynefin-framework

The Cynefin Framework helps in differentiating different situations and appropriate courses of action in each. In my opinion, the contemporary planning paradigm has assumed that training belongs to the ***complicated*** domain, where it actually belongs to complex domain, due numerous uncertainties involved and ***complex*** causal networks.

Contemporary planning strategies assumed predictability and tractability (***ludic fallacy***) in devising ***optimal*** periodization models (the complicated domain in the Cynefin framework). Unfortunately, or luckily, due to the many uncertainties involved, performance and performance planning belong to the complex and uncertainty domain. If you remember the story from the beginning of this chapter, we shouldn't approach training planning like we are building a factory in a predictable economy, but rather like building a startup within a questionable market. This means planning strategies should be more concerned with ***robustness***, rather than ***optimization***. To quote Gerd Gigerenzer: "When faced with significant irreducible uncertainty, the robustness of the approach is more relevant to its future performance than its optimality."

Planning in the performance domain revolves around answering the following questions:

1. What should be done?
2. When does it need to be done?
3. How do we minimize the risks of being wrong?

I will answer these questions from an uncertainty and robustness perspective, which is the basis of **Agile Periodization**, rather than from the ***ludic fallacy*** of believing that situations and individual reactions are predictable (and that there is an optimal solution). Similar to the Bayesian and Frequentists approaches in statistics (pardon my French), these two approaches can ***converge*** to the same solution under certain constraints.

To answer "What should be done?" I will turn to the concept of MVP, or minimum viable program (which can stand for minimum viable performance as well) and iterative planning. And to answer "When does it need to be done?" I will turn to the concept of ***microdosing*** (I believe coined, at least in performance domain, by sprint coach Derek Hansen). Concepts such as Nassim Taleb's ***Barbell Strategy***, as well as ***randomization*** needs to be covered, due their importance in answering both questions. The question of "How to minimize the risks of being wrong?" will be answered throughout the rest of this chapter.

What needs to be done?

You might be asking yourself "OK, I understand the 1/N heuristic, but how do I decide which assets?" That is an excellent question to which I do not have a concrete answer. Besides, the distribution in the performance domain will not be completely equal because no head coach will split training time to 50% practice and 50% physical preparation. But that is actually the point of using heuristics - simple rules of thumb that can guide your decision making in uncertainty.

In our case, what are the ***assets***? In my opinion those are ***qualities***. And now a more difficult question is, "what are ***qualities***?" I can only urge you to read the book ***Zen and the Art of Motorcycle Maintenance***, because it deals with the concept of qualities and establishes a new branch of philosophy called the ***metaphysics of Quality*** (Pirsig, 2011). But without going on a tangent here, I will present you with an analogy I love to use to describe the whole performance process and how the ***qualities*** emerge.

Imagine we have two racing cars (and two drivers driving them) – a red and a blue car. For the sake of example, imagine these two cars perform a time trial on a given course and they both reach the same time:

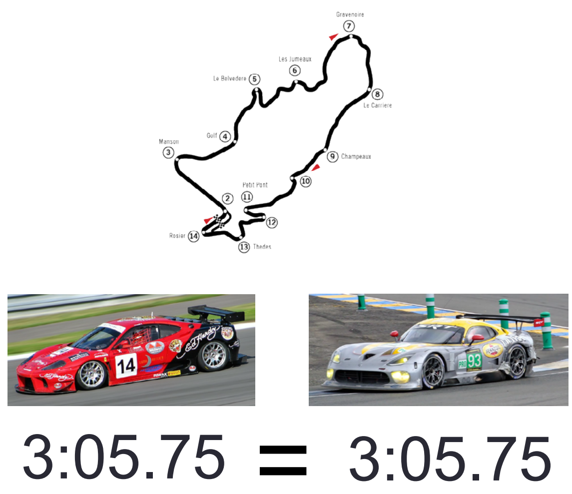


Figure 42. Racing cars with different qualities, but equal performance on time trial

The question that we might be asking is "***why is that***?" and in order to answer that question, we would need to know what the ***rate limiters are*** (which is the same as "lacking quality," or a quality that is holding one back). So pretty much everything revolves around rate limiters, but they are tricky and not easy to find out. Let's make the first major assumptions: the skills of the drivers are completely the same (this is a big assumption, but I will come back to it later) and there is no interaction between the cars (each is racing alone on the track). The problem is that we cannot infer what the rate limiters are (or the differences in the cars) solely from the achieved race times on this course. We need to dig deeper. We need to do some analysis.

We have three types of analysis, which I named:

1. Phenomenological analysis
2. Mechanistic (or Performance) analysis
3. Physiological analysis

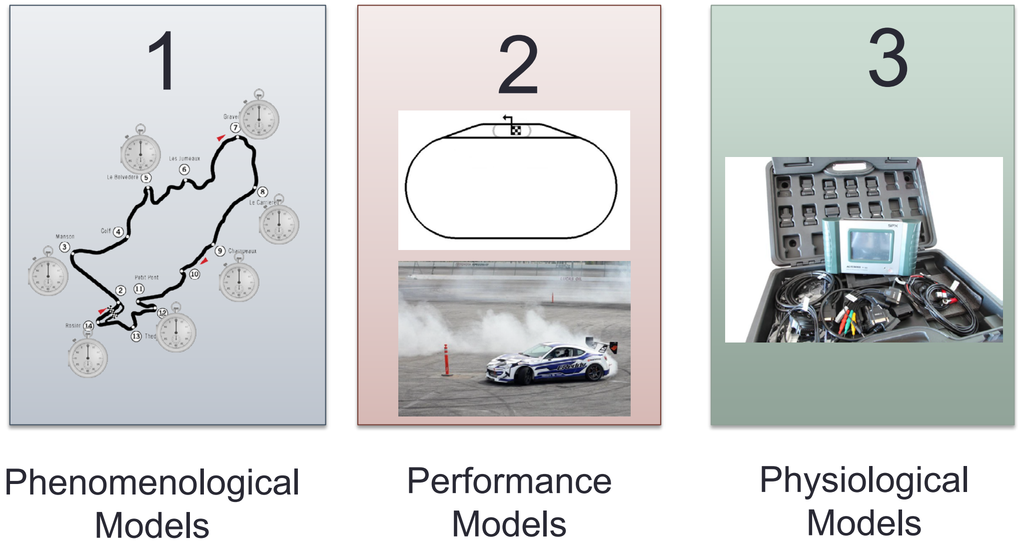


Figure 43. Three types of performance analysis – phenomenological, mechanistic and physiological

Phenomenological Analysis

Phenomenological analysis involves observations of the cars performing on the track and the use of the most basic instruments. For example, we might be interested in split times and from that we can infer that the red car is slower on the curves, but catches up on the straights. We have just identified strong and weak phenomenological qualities. This might be more than enough to guide your actions and try to create training interventions.

Mechanistic (or Performance) analysis

If we go one step further in trying to answer ***why*** the cars are having such and such performance on those particular parts of the course, we would need to ***isolate*** or ***constrain*** the cars to check how they behave. We will perform this type of analysis on a bunch of specialized tracks to evaluate each car's performance in different conditions. For example, we might have a VMAX test, or an agility polygon, and so forth. This will help us in being more certain about the qualities of the cars and rate limiters.

In the case that we are interested in what qualities exist (overall), we would need to test a bunch of cars on a bunch of courses and then perform something that is called a ***factor analysis*** or ***latent variable modeling***. This will tell us about underlying constructs that these tests are measuring, for example, VMAX on 1000m and VMAX on 2000m might measure the same ***thing*** (or quality). This is the basis of ***biomotor abilities*** models (Fleishman, 1964). Unfortunately, this analysis is never straight forward and the results are always conditional on the model (and subjects), the way the data is treated, reliability of the tests and so forth. Due to the error propagation and a bunch of assumptions, the results of a factor analysis should be seen as a ***satisficing*** model, rather than the ontological model of reality (***what exists out there***). Besides, the factor loadings are never black or white, so there is always overlap between identified constructs.

Contemporary planning strategies assume that these identified qualities represent ontological realities and are used as mechanistic building blocks to lay out the training plan (Bompa & Haff, 2009; Issurin, 2008b; 2008a; 2015).

Figure 44. Contemporary planning strategies assume that these identified qualities represent ontological realities and are used as mechanistic building blocks to lay out the training plan

Physiological Analysis

Having specialized tracks is a major step forward, but to answer ***why*** more precisely, we need to dig even deeper. To perform this type of analysis we need specialized tools or equipment. In other words – a laboratory. In the case of the cars, we might perform specialized tests on the engine or engine blocks, breaks, aerodynamics, suspension, you name it. When it comes to performance, this is the area of muscle fiber and blood samples, pulmonary gas analysis, EMG, and so forth.

The major problem is that we can always go deeper down the rabbit hole of analysis. The question is when or where should we stop? My answer to this question is to stop when the qualities identified are not functionally meaningful; when they do not have any actionable usability. This tends to differ between levels of the athlete (working with higher level athletes you would need to dig deeper to find limiting factors), but it is usually much more shallow than the lab coats would want us to believe. As a coach, you should be asking "What is the least amount of information I need to know to get the job done and keep these athlete and this team improving." I'm not sure that number of mitochondria will help you much there.

These are, in short, three levels of analysis and each results in their own models. The following picture depicts difference between coaches and lab coats when it comes to these three levels of analysis:

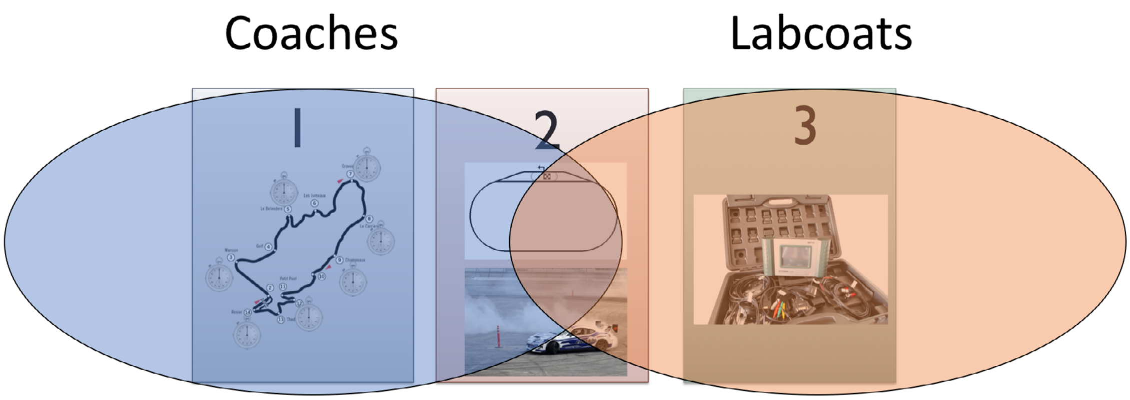


Figure 45. One of the reasons for misunderstanding between coaches and lab coats might be the language and analysis used to represent complex realities.

In my mind, this is one of the reasons for the clash between the two. Coaches tend to use more phenomenological and performance models, while lab coats tend to use more performance and physiological models. But this clash is nothing new - for example, a similar clash exist(ed) between ethologists and behaviorists. Ethologists studied animals in their natural habitat, while behaviorists studies them in an artificial lab environment. These issues are shared in personality/trait analysis, IQ and so forth. I might be wrong, but these are common in any ontological and epistemological endeavor. A similar, if not the same clash, exists between analytical and continental philosophy.

When I started working as a coach in professional clubs right after college, I noticed that coaches use their own phenomenological qualities, for example "strength in the duel" (team sports), or "final kick" (endurance), or "ability to maintain actions" (Raymond Verheijen uses these phenomenological qualities and promotes ***football language*** rather than ***physiological language*** (Verheijen, 2014)). I thought these were not really scientific and that physiologically defined qualities should be used instead, as they taught us in college. For example, aerobic endurance, VO_2max, anaerobic endurance, max power and so forth. But as I gained more experience, I realized the flaws of such an approach. I also noticed a few coaches and researchers losing a grip on reality by being focused on "objectively" defined physiological qualities. Nowadays I look at coaches as ***phenomenologists*** and I do NOT think they are ***less scientific*** for not using physiological models and language. For this reason I completely agree with Raymond Verheijen on using phenomenological models, but also while understanding the underlying physiology (Verheijen, 2014).

Since I am a ***complementarist***, I believe that all three types of analysis are important and needed. We cannot escape the physiological and biomechanical limits of our bodies or defy the laws of physics, so we need to understand those. On the flip side, the rate limiters are not as fixed as with other mechanical systems, but rather very flexible in humans (and other biological and complex systems, because of complex interactions).

One thing to realize is that qualities are not fixed, but emergent properties. Their emergence depends on the task demands, environmental constraints, and organism characteristics. For example, different things limit VO_2max in normoxia (sea level) compared to hypoxia (above 3,000m) or hyperoxia (under sea level, higher partial pressure of O_2).

The picture below depicts my **Grand Unified Theory** (GUT) model of performance. Using the GUT, I have tried to solve multiple conundrums in performance domains, applied to multiple scales. I will expand further on this model.

We have made the assumption that the skills of the drivers are not important in the car's performance. But imagine that a driver without any experience drives a Formula 1. What would be his limiting factors, or qualities, that are holding the performance back? Most certainly it would be his driving skill (or ***Form*** on the above graph), rather than the characteristics of the car (***Substance*** on the above graph). This Form/Substance complementary aspect is evident on any level of analysis. For example, if a soccer player improves his MAS (***substance***), his game performance will increase (***form***), or if the heart's stroke volume improves (***substance***), VO_2max will improve (***form***). In a way, these are ***fractal-like*** dimensions repeated through iteration ***all the way down***. We need to keep these in mind when discussing qualities.

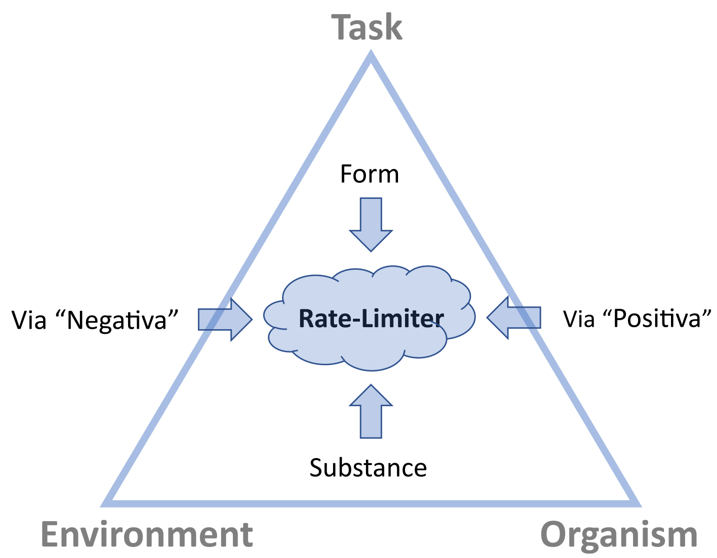


Figure 46. Grand Unified Theory of sport performance

Once we start talking about interventions for the identified qualities (rate limiters), we can take two complementary approaches - ***via Positiva*** and ***via Negativa*** (Taleb, 2014). Via positiva means adding more stuff (for example creating more mitochondria in the muscles), while via Negativa means removing stuff (e.g. producing less fatigue inducing compounds, or making an athlete more rested by removing things that impair his sleep hygiene). These are also ***fractal-like*** complementary pairs and need to be addressed when discussing qualities.

So, in the end, what are qualities? I will tell you what they are not - they are not physiological constructs (although it is important to understand them) or Russian-identified biomotor abilities. Qualities are something beyond the subjective/objective dichotomy; they are emergent under changing constraints and, with saying this, I want to empower you to identify them yourself. Let's imagine that the interaction between cars is important in the above race - not only between red and blue car, but between other cars as well. Immediately, we have a bunch of complex qualities that interact in creating the performance, some on the individual action level (skill/form and ability/substance) and some on the interaction level between the cars (tactics and strategy). For example, the tactical quality of a team to pressure an opponent when losing the ball, has ***NOTHING*** to do with physiology, but it is of utmost importance in team games, in this case soccer. In this way, physiology does not have the monopoly of defining what is real (ontology) or defining fixed limiters of performance, but it has a huge supporting role and it should not be neglected.

In sport science and sport performance in general, we are probably starting to suffer from ***scientism*** (Boudry & Pigliucci, 2018):

Scientism is the view that science is the measure of all things, that philosophical problems, ethical problems, aesthetic problems, and even questions of value can be reduced to science. All sciences should emulate physics, and all real sciences can be reduced to physics. --- Paul Gibbons and Massimo Pigliucci (Gibbons, Pigliucci, 2018)

Reducing performance and planning solely to ***objective*** physiological and biomechanical constructs might seem scientific and ***evidence-based***, but in truth it is scientism. Watch for it and don't neglect the phenomenology and the artistic and subjective side of things. But there is another danger - ***pseudoscience***, and it is even more present in performance cultures. The solution is again the middle-ground, in-between pseudoscience and scientism.

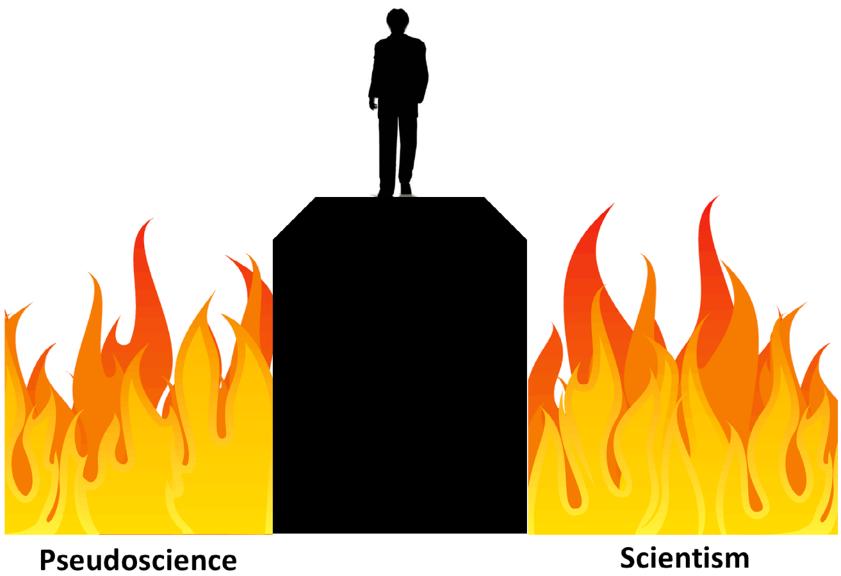


Figure 47. Walking on the fine line between pseudoscience and scientism

But we are not done yet, because defining qualities doesn't solve the issues of intervention. Contemporary planning strategies revolve around predictability, certainty, clearly defined objective performance qualities (e.g. biomotor abilities), and the assumption of ***directed methods***. By directed methods I refer to the fallacious belief that for every identified quality, there is a method that improves it. The image below depicts this perfectly:

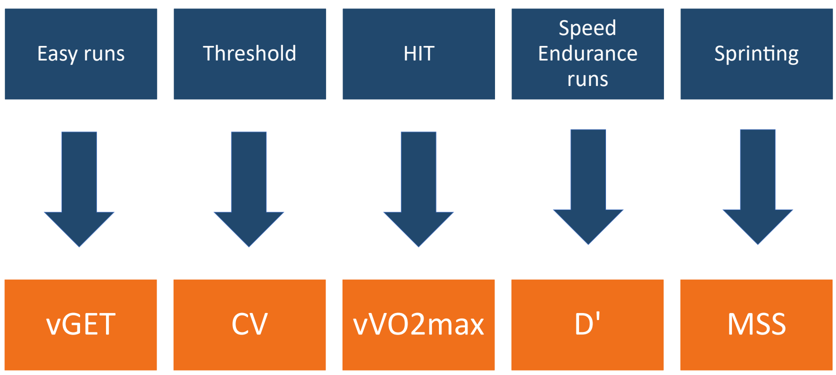


Figure 48. Flawed mental model of methods associated with certain determinants of performance

For example, if you want to improve VO_2max, you will perform HIT intervals. If you want to improve lactate threshold, you will perform lactate threshold runs. And so forth. Unfortunately, or luckily, this cannot be further from the truth.

For example, imagine a strength and conditioning coach starting to coach distance runners - he will use performance models and physiological models to base his decisions on what needs to be done. He or she might do VO_2max intervals, and so forth. What he or she is lacking are ***phenomenological*** models of distance running - understanding the race and defining important qualities from that viewpoint.

On the flip side, if an endurance coach comes to coach soccer, he or she might look at performance qualities such as being able to cover more distance in the game, while neglecting ***phenomenological*** qualities of team interactions and so forth.

For this reason it is important to understand a given sport from a ***phenomenological*** perspective, rather that pushing the square peg of physiological models into the round hole of complex performance qualities.

I would like to point to the **Hume's Is/Ought** problem here. This means that we cannot (or we have a hard time) deriving ***ought*** (what to do) from an ***is***. We have this chasm (or gap) between methods (ought) and qualities (is). For example, someone might improve his performance (and VO_2max) by doing a high volume of low intensity running, while someone else might do that same thing by performing HIT conditioning. We do not know in advance, although there are ***best practices*** (from practical tinkering) available that can help us set up, the starting points for further experimentation.

What I would love to suggest here is that this gap differs between the three mentioned analyses:

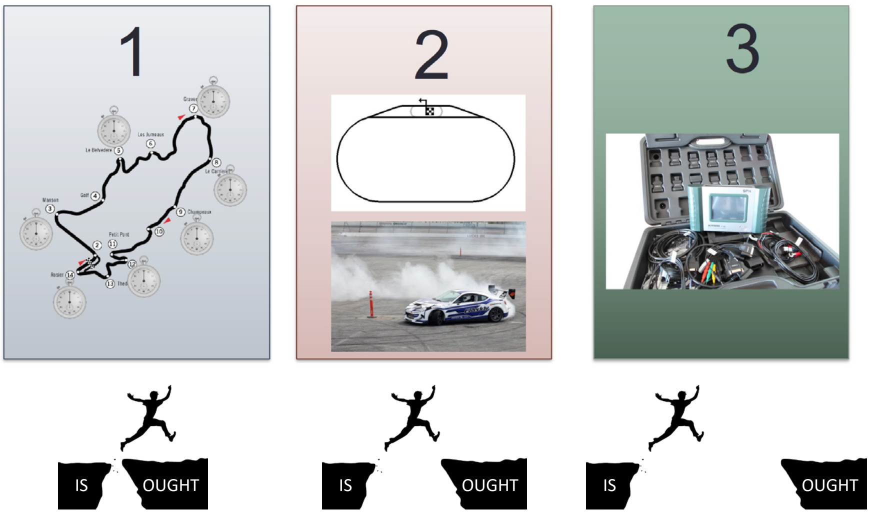


Figure 49. Hume's Is/Ought gap increase more and more from phenomenological analysis (and qualities identified) to physiological analysis

For example, if you define the number of mitochondria as an important quality (physiological analysis), what should you do to increase it? Beats me!

But if you define a quality as improving the final kick in a 5k race (phenomenological), then the method to do that will be much more apparent and most likely more linked to the effect. But we could still be wrong.

We do have this gap between method and quality (is/ought) and we are never certain that a specific method or intervention will improve a specific quality. For this reason, I dislike stating objectives (or training components) in terms of qualities, but rather methods. Because we can control what we do, but we cannot control what we are going to get. I have avoided calling certain HIT drills ***aerobic***, or ***anaerobic***, or whatever, but rather classify them, not by what I plan hitting with them, but rather where they phenomenologically differ. I am more certain about how I am going to perform the drills than to which physiological system they are going to hit and what adaptation stimuli they are going to create.

This is similar to Stoic philosophy of controlling what we can and accepting what we can't. We can control what we do (methods), but not what we will achieve (qualities). The following picture depicts this perfectly:

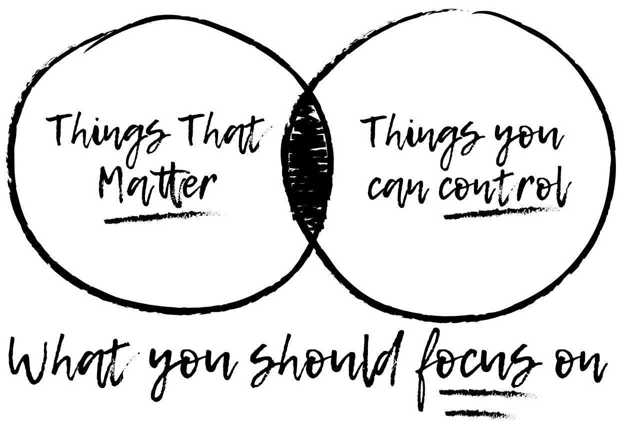


Figure 50. Perfect depiction of Stoic philosophy of focusing on things you can control. Image modified based on Carl Richards sketches at Behavior Gap. Available at http://hinmanfp.com/portfolio-item/what-you-should-focus-on/)

In a way, we need to figure out what the most important methods are ("Things that matter") that we can control, but we still need to embrace the uncertainty. So we define the important methods based on the three levels of analysis (mostly phenomenological), but what if we are wrong? We most likely are. And that is the name of the game. So rather than trying to be right, or creating an optimal program based on fallacious assumptions of the existence of biomotor abilities and corresponding methods to achieve them, we acknowledge and embrace being wrong (and uncertainties), but we seek to utilize the most robust planning approaches and strategies that protect us from the ***downside*** (the bad things that might happen if we are wrong, sometimes even if we are right, which is more painful) and help us reap the benefits of the ***upside*** (the great things that might happen if we are right, sometimes even if we are not) (Taleb, 2014). But before digging into these and HIT planning, let's summarize what has been said so far.

- Qualities (limiting factors) are hard to pinpoint and they defy subjective/objective categorization
- Qualities are fractal-like and emergent; they have flexible limits
- You are the one that defines (and redefines) qualities
- We have three types of analysis: phenomenological, performance and physiological, of which all three are important, but phenomenological is the most usable
- Every quality has a form/function complementarity aspect, as well as a via Negativa/via Positiva approach in addressing them
- There is gap between methods (ought) and qualities (is). Just because you assume what there is, you do not know what to do with it
- It is better to define training objectives (or components) as methods, rather than qualities
- Due to the uncertainties and complexities involved, we are probably wrong, so we need to utilize the most robust planning strategies, rather than optimal (because optimality revolves around assumptions of predictability).
- Robust > optimal

Enough of this metaphysics - how is this applied to HIT conditioning? What qualities and/or methods are important and how should planning be done to achieve the highest robustness in the face of uncertainties?

It is hard to give concrete answers overall, especially from only the HIT scale. We would need to look at the whole training system and how HIT fits in (among other training components), as well as if it needs to be done in the first place. In a way, the simplest heuristic is that ***some HIT should be done***, because not everything can be covered (in team sports) with skill practices, and we need some isolation to overload and create adaptation stimuli (Gabbett & Mulvey, 2008). I will discuss this topic in a bit. But let's discuss how planning heuristics of deciding ***what should be done*** can be applied on the level of HIT solely.

Imagine we enlist all the important methods (this can be applied on the training system level, or at HIT level only; in a way, there are hierarchies):

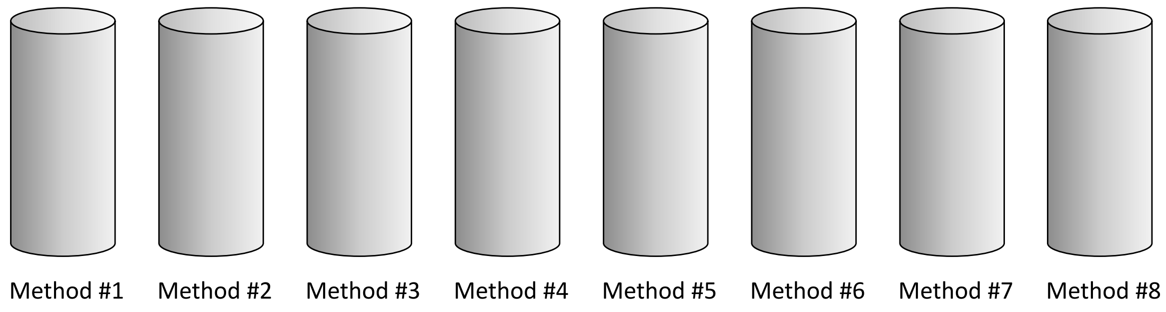


Figure 51. The main problem in planning is deciding where to allocate resources

If we wish to apply the 1/N heuristic in real life, we need to minimize the amount of categories (in this case, the number of methods), since we are constrained for time and energy. To paraphrase Jordan Peterson: "Categories are constructed in relationship to their functional significance." We need to use only those categories or methods that are functionally significant to us (in our own constraints). So Heuristic #1 is ***make it simple***:

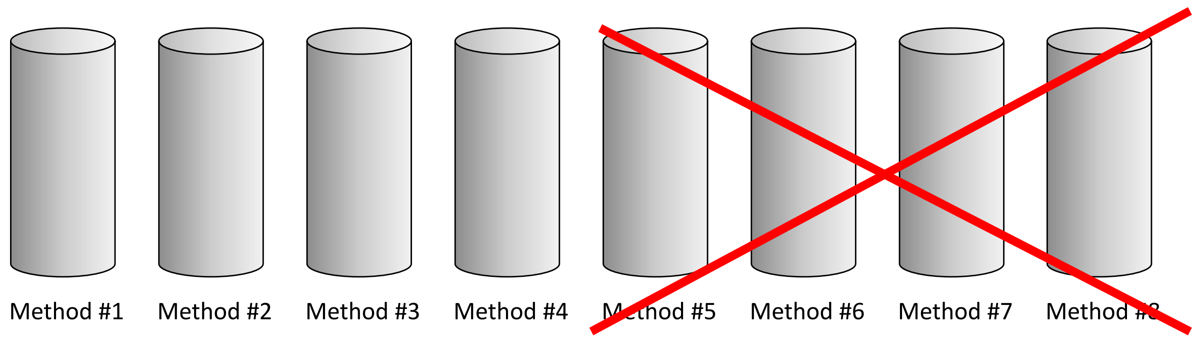


Figure 52. Heuristic #1 is minimizing numbers of important qualities

If we wish to apply this to HIT drills, the top selection in my mind would be tempo HIT, followed by short intervals, followed by RSA, and then SIT, and then finally long intervals. If I could choose only one HIT variation, that would be tempo strides.

In a way, we want to enlist all the most ***potent*** methods - something that brings the biggest benefit for the time and energy invested (e.g. think of big rocks and the jar story, or the Pareto 80/20 principle).

Once we trim (or at least provide some ordering) the ***buckets*** (methods), using Heuristic #2 (1/N), which is to distribute equally (or as equally as possible), we would need to hit all the methods at least a little bit:

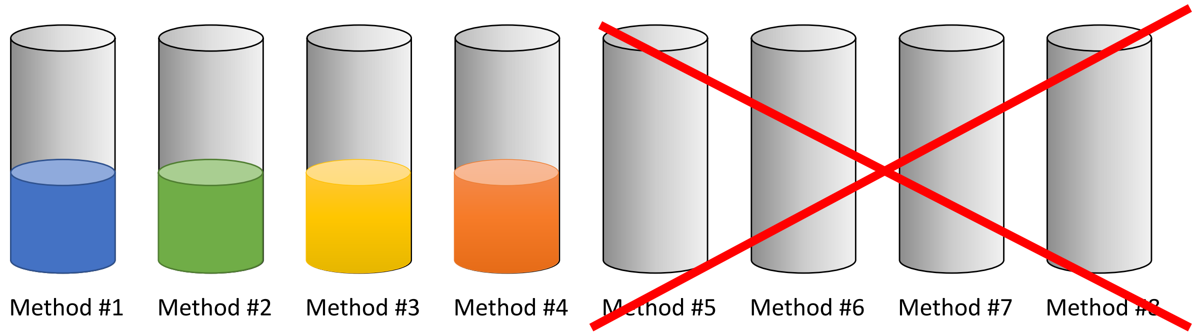


Figure 53. Heuristic #2 – distribute as "equally" as possible into all important assets (1/N)

This is the most robust planning strategy. Is it optimal? Probably not. But it is a ludic fallacy to believe in optimality in a complex and uncertain system. We can probably state, in retrospect, what things might have been done better, but we cannot say that for the future.

Combining Heuristic #1 (Simplify) and Heuristic #2 (1/N) help us in creating a MVP - ***Minimum Viable Program*** and ***Minimum Viable Performance***. In a way, we are looking to create a minimalistic program that can help us experiment (while being robust) and bring a minimum viable performance when needed. This way we do not strive away from ***competitive performance*** too much. For example, wasting one month on doing only long slow distance on sandy dunes for a soccer player might be optimal from a physiological perspective, but it might be fragile from a risk/uncertainty perspective since his or her performance will be completely distant from his or her competition readiness and the training method selection would be very unidirectional and hence, very risky. This is the same as with the ***overreaching*** Russian periodization secrets, where one would overreach the athlete in the hope of the athlete super-compensating down the road. If you do this to a multimillion dollar soccer player and he fails to perform well (i.e. minimum viable performance) during the friendly games, you will either lose the trust of this player, or even worse, you will lose your job.

These concepts fit perfectly with the ***barbell strategy*** concept by Nassim Taleb (Taleb, 2014):

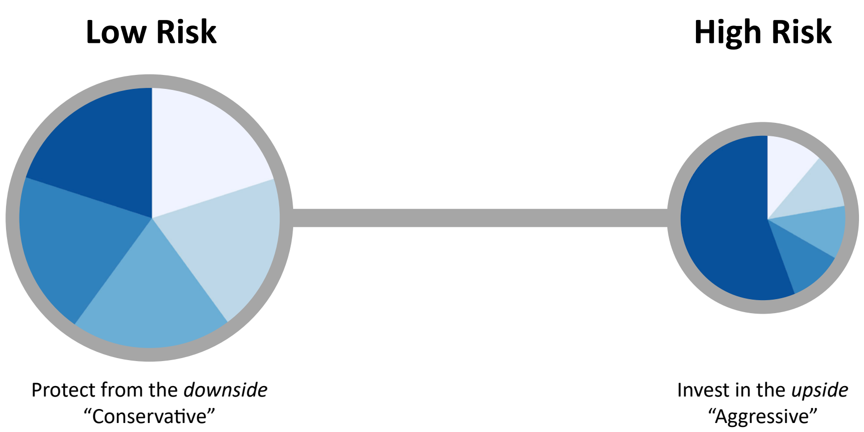


Figure 54. Nassim Taleb's Barbell Strategy

According to Taleb, most investments should go to ***protecting from the downside*** - just making sure that the bad things don't hurt us. This is achieved with MVP and the 1/N heuristic. In a way, this is making sure we are not going to be terribly wrong (as in doing months of dune jogging with a multimillion dollar soccer player) and avoiding being a sucker. To do that, we need to invest, as equally as possible, into all important assets. This provides robustness. It makes sure that if we are wrong, we are not going to be terribly wrong. This is a risk-averse strategy, or "glass is half empty and most likely broken" (which suits my pessimistic nature).

If you think about it, all unidirectional training programs are very fragile. What if they do not work? What if you wasted one month in building up the lactate threshold of the athletes in the hope of them covering more ground during a game and recovering faster? If that doesn't work, you just wasted a whole month of training and invested in a failed asset.

Once we cover the downside protection, then we are more free to invest in the potential upside (right side of the barbell). This represents Heuristic #3 - "Invest in the upside":

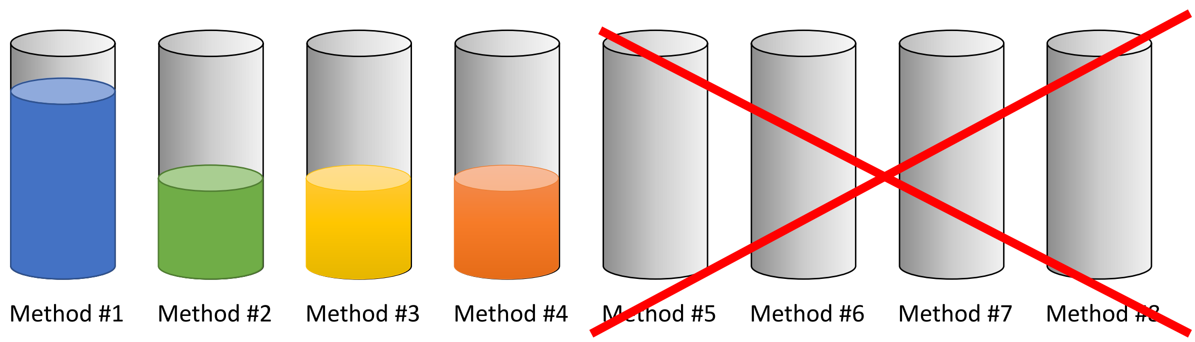


Figure 55. Heuristic #3. Once you cover all the major qualities using 1/N strategy, you are able to invest more in potential upside depending on identified need or based on logistical limitations

This way we are free to take a risks and invest more in a single asset. This makes planning ***antifragile*** - if things fail, they won't fail miserably, but if they work, they will work wonderfully (Taleb, 2014).

In real life we are constrained for time and energy available so, in a way, using Heuristic #3 is very practical because we cannot emphasize all the important methods and to stimulate a given quality, a certain level of ***saturation*** might be needed (especially with advanced athletes). Contemporary planning makes us believe that there is something special about following a certain order of emphasis blocks - e.g. aerobic block, strength block, anaerobic block, and so forth. Although there is a proven ***phase potentiation*** effect from following a certain order of the blocks, studies showing this effect is short in duration and/or observed in only one ***cycle***. Once you repeat the cycle multiple times (i.e. real life training), there is probably nothing special about following a specific order or emphasis. But this is not in disagreement with Heuristic #3, because once you sort out heuristics #1 and #2 (and create MVP), you are free to experiment. Just note that there is no need to go through a certain order of emphasis because some Eastern European scientist said so. You can use ***criteria based periodization*** instead.

For example, if someone lacks a certain quality (which you measure with certain criteria), you can experiment and see if putting more emphasis on a given method helps in that regard. For example, rather than going through an emphasis cycle of long intervals, short intervals, tempo, SIT, RSA and so forth, you can emphasize more long intervals for a complete beginner or someone with a really low MAS (while making sure you touch other methods as well - Heuristic #2). Or with someone who is weak as a kitten in the back squat, you can put more emphasis on strength training methods. Another guiding heuristic might be ***Liebig's law of the minimum*** (Reilly & Fuglie, 1998):

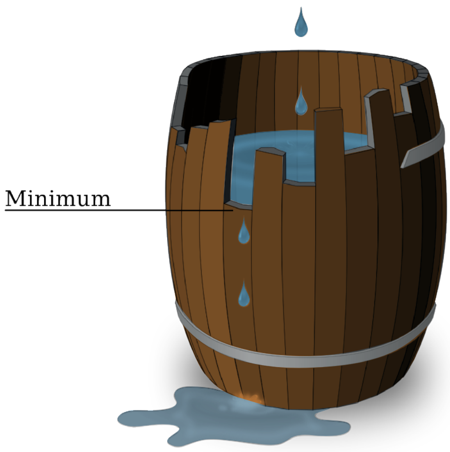


Figure 56. ***Liebig's law of the minimum. Taken from Wikipedia. Available here: https://en.wikipedia.org/wiki/Liebig%27s_law_of_the_minimum***

Liebig's law of the minimum comes from agricultural sciences and it states that the growth of the plant is dictated not by total resources available, but by the scarcest resource (the limiting factor) (Reilly & Fuglie, 1998). In the above barrel example, to raise the water level, one needs to rise the shortest stave. Applied to training, the best investment would be to emphasize the lagging quality (i.e. weakness) since it probably has most potential for improvement, although some training philosophies might disagree and state that ***strengths*** should be emphasized. The beauty of **Agile Periodization** is that it is flexible enough for you to try different paradigms.

You probably remember from the SIT discussion that I stated that COD and extensive versions should be done before doing intensive or straight line. If that is not phase potentiation, what is it then? It is about avoiding downside, rather than reaping the upside, as well as using the ***law of the minimum***. In other words, it is about avoiding injuries or training-stress related issues, as well as using the least stressful training methods that get the needle moving forward, which are also very useful in the beginning of a new training phase (e.g. preseason). It seems like this is phase potentiation, but it is not. Phase potentiation states that using method A before method B improves performance more than using method B before using method A, but as already alluded, this is probably not the case once A,B,A,B,A,B are repeated numerous times.

Another way to approach emphasis order might be to simply ***randomize***. This is not the same as throwing a plate of pasta against the wall and seeing what sticks, or performing the Crossfit Workout of the Day (WOD), but rather randomizing under the constraints of ***best practices***. We do identify what is important, but due to real life limits, we cannot give the same emphasis to every quality and we are not certain if the order matters. To avoid the paralysis of ***Buridan's donkey*** (Taleb, 2007; 2014) (a donkey that is right in the middle between two hay bales starves to death because he is undecided where to go), we might ***flip the coin*** (i.e. use randomness). We have been afraid of randomness for a long time (i.e. Fortuna vs. Minerva, or Apollonian vs. Dionysian) (McElreath, 2016), but recently computer scientists are discovering the wonderful powers of randomization and how helpful it is. To make things more complex than coin flipping, one can use ***Markov Models,*** where the probabilities of the switches between phases are defined. But this is a topic for another manual.

Utilizing Heuristics #1, #2 and #3, as well as aiming for the Minimum Viable Performance and Minimum Viable Program is the most robust planning strategy one can use in an uncertain and complex performance world. As stated numerous times, this might not be optimal from a physiological standpoint, but optimality is the lab coats' wet dream - we should strive for robustness instead. But again, what if we are wrong?

One simple, **Agile Periodization** principle that minimizes being wrong, besides using MVPs and heuristics, is to use ***iterative planning*** (Layton & Ostermiller, 2017; Rubin, 2012; Sutherland & Sutherland, 2014) and ***embedded testing***.

In contemporary planning strategies, ***upfront planning*** is being emphasized. If you do not have a laid-out annual plan up front, in details, then you are a failure. But this is all based on the predictability fallacy and the ***waterfall*** approach to planning (Layton & Ostermiller, 2017; Rubin, 2012; Sutherland & Sutherland, 2014):

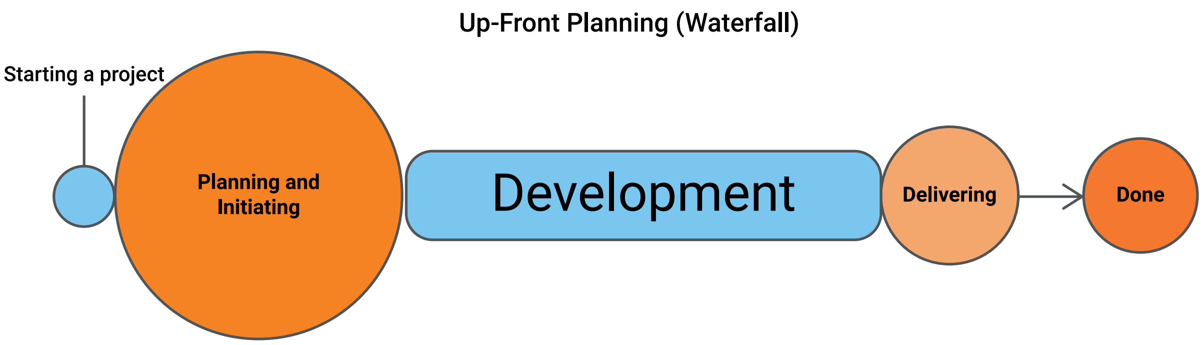


Figure 57. Upfront planning – the basis of contemporary planning strategies, which assumes predictability of training effects. Image modified based on http://www.donlowe.org/project-management/seven-core-processes/planning-and-initiating-process/rolling-wave-planning/)

With iterative planning, you aim to plan ***as little as possible*** and in iterations (usually called sprints in the Agile software development):

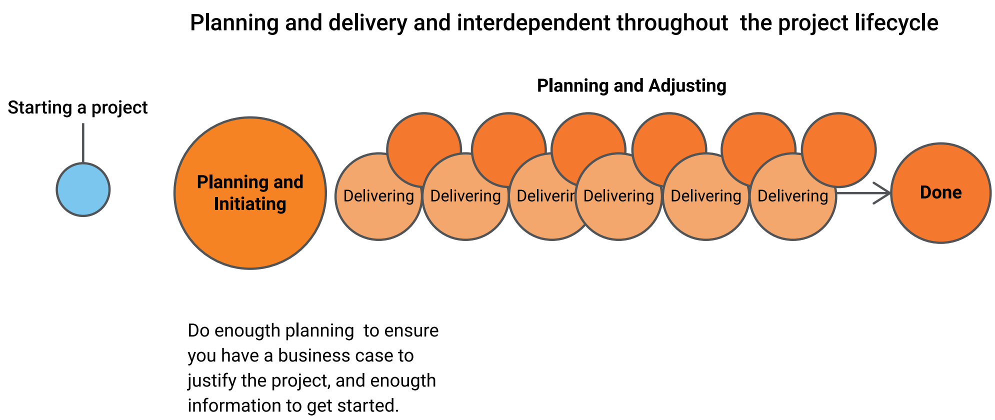


Figure 58. Iterative planning – the basis of Agile Periodization, which appreciates uncertainty. Image modified based on http://www.donlowe.org/project-management/seven-core-processes/planning-and-initiating-process/rolling-wave-planning/)

So planning and delivery are intertwined throughout the training, rather than being in distinctive phases. In the Agile methodology, plans are being developed and realized in time-boxed iterations, called ***sprints*** (Layton & Ostermiller, 2017; Rubin, 2012; Sutherland & Sutherland, 2014). At the beginning of each sprint there is a planning meeting and throughout each sprint there are short meetings called ***daily stand-ups***. At the end of each sprint there are two review meetings - **sprint retrospective** and **sprint review**. Application of these processes to team management is beyond this manual, although very important since, in my experience, most high-level elite teams fail due to confusing communication and lack of transparency (which Agile helps alleviate).

So rather than having a yearly plan up front, plan as little as possible and then iterate. You will learn along the way. The key is having demonstrable performance (minimum viable performance) at the end of each sprint (or multiple sprints called ***releases***) and collecting data throughout the sprint itself - ***embedded testing***.

Embedded testing might involve using GPS analysis, or generally collecting data without disrupting training and use that to make and suggest corrections during sprint review and sprint retrospective. So even if you are wrong, you will not be wrong for a long time (if you check the course and adjust during iterations).

You are not cursed to follow a created hierarchy of qualities and needs, but as you learn, as your athletes improve, you will see new things that might be worth analyzing and emphasizing, something that you hadn't been aware of before or wasn't important before. The key is the iterative review process.

Let's give a few concrete examples for "what should be done." I will break the rule of not doing too much long term planning in the following examples. Imagine we have three slots for HIT in a week and we need to figure out what should be done. Here are few planning strategies:

Strategy #1 (Sequential or Uni-Directional Planning)

The simplest planning strategy would be to devise a few weeks (sprints) into a single ***bucket*** (in this case HIT type):

Week 1			Week 2			Week 3		
Active Long Intervals			Active Long Intervals			Active Long Intervals		
2:1	2:1	2:1	2:2	2:2	2:2	2:4	2:4	2:4
Week 4			Week 5			Week 6		
Passive Long Intervals			Passive Long Intervals			Passive Long Intervals		
2:1	2:1	2:1	2:2	2:2	2:2	2:4	2:4	2:4
Week 7			Week 8			Week 9		
Active Short Intervals			Active Short Intervals			Active Short Intervals		
20:10	20:10	20:10	20:20	20:20	20:20	20:40	20:40	20:40
Week 10			Week 11			Week 12		
Passive Short Intervals			Passive Short Intervals			Passive Short Intervals		
20:10	20:10	20:10	20:20	20:20	20:20	20:40	20:40	20:40
Week 13			Week 14			Week 15		
Tempo			Tempo			Tempo		
15:45	15:45	15:45	15:45	15:45	15:45	15:45	15:45	15:45

Figure 59. Long Sequential planning strategy without any variation within given week

This is a fine strategy for someone who has ample of time to prepare or who is just starting up. It is problematic for someone who is already ***in shape*** and needs to perform as soon as possible (for example, in soccer you might have 5-6 weeks to prepare and probably only a week or two until the first friendly game). It also breaks the 1/N rule and assumes a lot of predictability and sequentiality. Thus, not a very robust strategy.

One thing to keep in mind is, what is the ***time frame*** over which the 1/N heuristic should be applied? It is hard to give a concrete answer since it could be one week, one sprint, or one ***release phase***. In addition, does N correspond to all HIT variations or only to the gross categories (long intervals, short intervals, tempo, SIT, RST)? It is hard to give a concrete and exact answer because there isn't one. But, as alluded to before, N should be the highest resolution categories that are functionally significant. In plain English, that would be gross HIT categories (I will refer to them as ***buckets***).

You probably noticed that the weeks in a given phase progressed from extensive, to normal, to intensive variations, while being of the same duration. You can vary this within a week as well:

Week 1			Week 2			Week 3		
Active Long Intervals			Active Long Intervals			Active Long Intervals		
2:1	1:30''	3:1'30''	2:2	1:1	3:3	2:4	1:2	3:6
Week 4			Week 5			Week 6		
Passive Long Intervals			Passive Long Intervals			Passive Long Intervals		
2:1	1:30''	3:1'30''	2:2	1:1	3:3	2:4	1:2	3:6
Week 7			Week 8			Week 9		
Active Short Intervals			Active Short Intervals			Active Short Intervals		
20:10	30:15	10:5	20:20	30:30	10:10	20:40	30:60	10:20
Week 10			Week 11			Week 12		
Passive Short Intervals			Passive Short Intervals			Passive Short Intervals		
20:10	30:15	10:5	20:20	30:30	10:10	20:40	30:60	10:20
Week 13			Week 14			Week 15		
Tempo			Tempo			Tempo		
15:45	10:30	30:90	15:45	10:30	30:90	15:45	10:30	30:90

Figure 60. Long Sequential planning strategy with variation within given week

In the above variation, you vary duration within a ***bucket***. You can also vary the type (extensive, intensive, normal). Plenty of options.

There is a slight improvement of this strategy when utilizing ***funnel periodization*** (Magness, 2013):

Week 1			Week 2			Week 3		
Active Long Intervals			Active Long Intervals			Active Long Intervals		
2:1	Tempo	2:1	2:2	Tempo	2:2	2:4	Tempo	2:4
Week 4			Week 5			Week 6		
Passive Long Intervals			Passive Long Intervals			Passive Long Intervals		
2:1	Tempo	2:1	2:2	Tempo	2:2	2:4	Tempo	2:4
Week 7			Week 8			Week 9		
Active Short Intervals			Active Short Intervals			Active Short Intervals		
20:10	SIT	20:10	20:20	SIT	20:20	20:40	SIT	20:40
Week 10			Week 11			Week 12		
Passive Short Intervals			Passive Short Intervals			Passive Short Intervals		
20:10	RST	20:10	20:20	RST	20:20	20:40	RST	20:40

Figure 61. Example of "funnel periodization" applied to HIT planning strategy

Using a funnel, you ***attack*** adaptation from two sides (slow speed and high speed) and they slowly converge over time. This is quite common in endurance sports, but hard to apply to a letter in team sports since there is not a single distance/duration to be trained for. In team sports the solution might be to inject faster HIT variations in the phases of slower HIT emphasis and vice versa. In a way to ***cover*** both aspects and move towards the 1/N heuristic. This strategy is quite useful in HIT planning.

A potential solution that approaches the 1/N heuristic would be to shorten the emphasis phases:

Week 1			Week 2			Week 3		
Active Long Intervals			Passive Long Intervals			Active Short Intervals		
2:1	2:2	2:4	2:1	2:2	2:4	20:10	20:20	20:40
Week 4			Week 5			Week 6		
Passive Short Intervals			Tempo			SIT		
20:10	20:20	20:40	10:30	15:45	30:90	30ec ext	40ec ext	20ec int
Week 7			Week 8			Week 9		
RST			Active Long Intervals			Passive Long Intervals		
2sec	3sec	4sec	2:1	2:2	2:4	2:1	2:2	2:4
Week 10			Week 11			Week 12		
Active Short Intervals			Passive Short Intervals			Tempo		
20:10	20:20	20:40	20:10	20:20	20:40	10:30	15:45	30:90
Week 13			Week 14			Week 15		
SIT			RST			Active Long Intervals		
30ec ext	40ec ext	20ec int	2sec	3sec	4sec	2:1	2:2	2:4

Figure 62. Short Sequential planning strategy

This strategy is, in my mind, much better and can also utilize variations within ***buckets*** – different durations of HIT drills or different types (extensive, normal, intensive). The order of the phases might be different and, in this example, a linear increase in HIT intensity is utilized. There's nothing magical regarding following a certain scheme as I have explained previously.

One potential issue with all of the above strategies (less with funnel variation) is the switch from emphasis phases (especially when they are long), which can cause stress related issues. In the same vein, what happens after the whole cycle ends? Is it just repeated or is something else being performed?

Strategy #2 (Mixed or Parallel)

Strategy #2 is a true 1/N approach. Every training session is of a different HIT type:

Week			
Week 1	PLI	Tempo	ASI
Week 2	SIT	ALI	RST
Week 3	PSI	PLI	Tempo
Week 4	ASI	SIT	ALI
Week 5	RST	PSI	PLI
Week 6	Tempo	ASI	SIT
Week 7	ALI	RST	PSI
Week 8	PLI	Tempo	ASI
Week 9	SIT	ALI	RST
Week 10	PSI	PLI	Tempo
Week 11	ASI	SIT	ALI
Week 12	RST	PSI	PLI
Week 13	Tempo	ASI	SIT
Week 14	ALI	RST	PSI
Week 15	PLI	Tempo	ASI

Figure 63. Mixed/Parallel Planning strategy. This is a showcase for 1/N heuristic in HIT planning

With this strategy, we have achieved the shortest time of the ***cycle***, or in other words, how long it takes to repeat all the HIT variations. In other words, this is closest to the 1/N heuristic, which makes it the most robust strategy, but it might lack ***saturation*** for a given HIT quality (whatever that might be) to be stimulated. It also might be too jumpy, especially at the beginning of preparation in which athletes need more time to become ***receptive*** for more strenuous HIT variations or they might not be needed in the first place (using the principle of minimum stress for maximum benefit, for example, in recreational athletes).

The solution would be to employ the barbell strategy and utilize emphasis phases as well as 1/N as much as possible.

Strategy #3 (Combinations)

There could be numerous combinations that fit with the barbell strategy. As mentioned, the funnel approach (or doing some higher intensity HIT within a slow intensity HIT emphasized block and vice versa) fits here and it is a viable strategy that helps in not being too far removed from all the bases (in other words, the 1/N heuristic). Two other options might involve the following:

Week 1	Active Long Intervals	PSI	1:30''	Tempo
Week 2	Active Long Intervals	ASI	1:1	SIT
Week 3	Active Long Intervals	RST	1:2	PSI
Week 4	Passive Long Intervals	Tempo	1:30''	ASI
Week 5	Passive Long Intervals	SIT	1:1	RST
Week 6	Passive Long Intervals	PSI	1:2	Tempo
Week 7	Active Short Intervals	ALI	30:15	Tempo
Week 8	Active Short Intervals	PLI	30:30	SIT
Week 9	Active Short Intervals	RST	30:60	ALI
Week 10	Passive Short Intervals	Tempo	30:15	PLI
Week 11	Passive Short Intervals	SIT	30:30	RST
Week 12	Passive Short Intervals	ALI	30:60	Tempo
Week 13	Tempo	PSI	10:30	ALI
Week 14	Tempo	SIT	10:30	ASI
Week 15	Tempo	RST	10:30	PLI

Figure 64. Combined planning strategy – long sequence with two sessions rotated in a week

In this approach, only one emphasis workout is performed. This way the emphasis is lower, but the 1/N heuristic is being followed more. The next solution reduces the 1/N heuristic but increases saturation (emphasis) of a given HIT method by performing two phase emphasis workouts:

Week 1	Active Long Intervals	2:1	PSI	3:1'30''
Week 2	Active Long Intervals	2:2	ASI	3:3
Week 3	Active Long Intervals	2:4	Tempo	3:6
Week 4	Passive Long Intervals	2:1	SIT	3:1'30''
Week 5	Passive Long Intervals	2:2	RST	3:3
Week 6	Passive Long Intervals	2:4	PSI	3:6
Week 7	Active Short Intervals	20:10	ALI	10:5
Week 8	Active Short Intervals	20:20	Tempo	10:10
Week 9	Active Short Intervals	20:40	PLI	10:20
Week 10	Passive Short Intervals	20:10	SIT	10:5
Week 11	Passive Short Intervals	20:20	ALI	10:10
Week 12	Passive Short Intervals	20:40	RST	10:20
Week 13	Tempo	15:45	PLI	30:90
Week 14	Tempo	15:45	SIT	30:90
Week 15	Tempo	15:45	ALI	30:90

Figure 65. Combined planning strategy – long sequence with one sessions rotated in a week, and two being from a given emphasis

The above variations involve longer emphasis phases, but this could be implemented in a shorter version as well:

Week	Emphasis			
Week 1	Active Long Intervals	2:1	Tempo	2:4
Week 2	Passive Long Intervals	2:1	Tempo	2:4
Week 3	Active Short Intervals	20:10	SIT	20:40
Week 4	Passive Short Intervals	20:10	RST	20:40
Week 5	Tempo	10:30	ALI	30:90
Week 6	SIT	30ec ext	PLI	20ec int
Week 7	RST	2sec	ALI	4sec
Week 8	Active Long Intervals	2:1	Tempo	2:4
Week 9	Passive Long Intervals	2:1	Tempo	2:4
Week 10	Active Short Intervals	20:10	SIT	20:40
Week 11	Passive Short Intervals	20:10	RST	20:40
Week 12	Tempo	10:30	ALI	30:90
Week 13	SIT	30ec ext	PLI	20ec int
Week 14	RST	2sec	ALI	4sec
Week 15	Active Long Intervals	2:1	2:2	2:4

Figure 66. Combined planning strategy – short sequence with one session rotated in a week and two being from a given emphasis

The take home message is that using heuristics gives you the freedom to apply and they are not restrictive. You do not need to follow dogmatic Russian science research on periodization.

Random order of emphasis, or?

There is nothing wrong in making the order of emphasis blocks ***random*** or following linear intensification (using more and more intensive HIT variations). This can also be said in terms of the 1/N heuristic - it can be random as long as all the bases are covered (which can mean doing more intensive HIT variations in a less intensive emphasis phase; the specific selection is up to you). If you follow the heuristics, you are free to experiment, which is indeed freeing.

This works because in real life we are constrained and we need a blend between variation and saturation, so the only solution might be to rotate the emphasized method/quality. Nothing special regarding the order of the emphasis blocks - it is just a practical necessity.

Emphasis phases can be adapted to the individual rather than everyone following the same pattern. For example, if you decide that a certain individual needs more RST or SIT training, why does he or she need to go through a long interval phase (as long as he or she performs some of it using the 1/N heuristic)? This represents

criteria based planning and it is easily adapted into iteration planning. So rather than having a random order of emphasis phases, it is decided through iterations of what might be the best emphasis for a given individual based on the data you collected through embedded testing. That is the beauty of iterative planning and **Agile Periodization** in general.

Practically speaking, a team can be split into clusters of athletes with similar HIT needs and as long as the 1/N is being followed as much as possible, they can follow their emphasis phase, rather than everyone following the same pattern. This will be a bit more administration intensive, but if deemed needed, it is a worthwhile strategy. For example, a team might have two HIT sessions a week of which one is used for the 1/N strategy and the other is an identified HIT variation that the coach believes is needed for a given group of athletes. Once the iteration cycle is done (sprint or a few sprints), re-evaluate and decide about the next cycle. This is how planning should work in uncertain and complex domains such as human performance.

The following picture depicts using one HIT workout for individual needs that are identified and that should receive more saturation. The other two workouts are the 1/N strategy of making sure we cover all the bases while experimenting with the idea that this individual (or group of athletes) needs more unidirectional work. This can work for the HIT component of the training program only or for the training program as a whole. When you cover your bases (1/N heuristic, protect from downside), then you are free to experiment with the potential upside.

Week 1	PLI	IND	ASI
Week 2	SIT	IND	RST
Week 3	PSI	IND	Tempo
Week 4	ASI	IND	ALI
Week 5	RST	IND	PLI
Week 6	Tempo	IND	SIT
Week 7	ALI	IND	PSI
Week 8	PLI	IND	ASI
Week 9	SIT	IND	RST
Week 10	PSI	IND	Tempo
Week 11	ASI	IND	ALI
Week 12	RST	IND	PLI
Week 13	Tempo	IND	SIT
Week 14	ALI	IND	PSI
Week 15	PLI	IND	ASI

Figure 67. Mixed/Parallel Planning strategy with one session being based on individual need

Top-Up Approach

Why would you do HIT in the first place? That's a fair question. The usual answer is very reductionistic and based on the dichotomistic form/substance model:

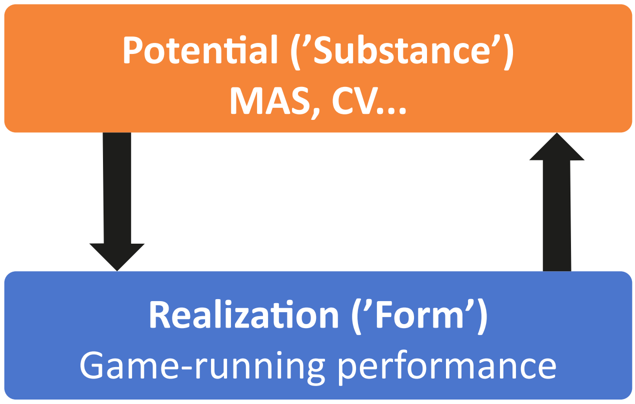


Figure 68. Substance ~ Form model applied to performance.

In this model, the goal of HIT is to increase ***latent qualities*** (substance, biomotor abilities), such as MAS, VO_2peak, vLT and so forth and then the realization (form) will follow in improved game-running performance or work capacity.

This model is also very well depicted in the works of Yuri Verkhoshansky (Y. Verkhoshansky & Verkhoshansky, 2011):

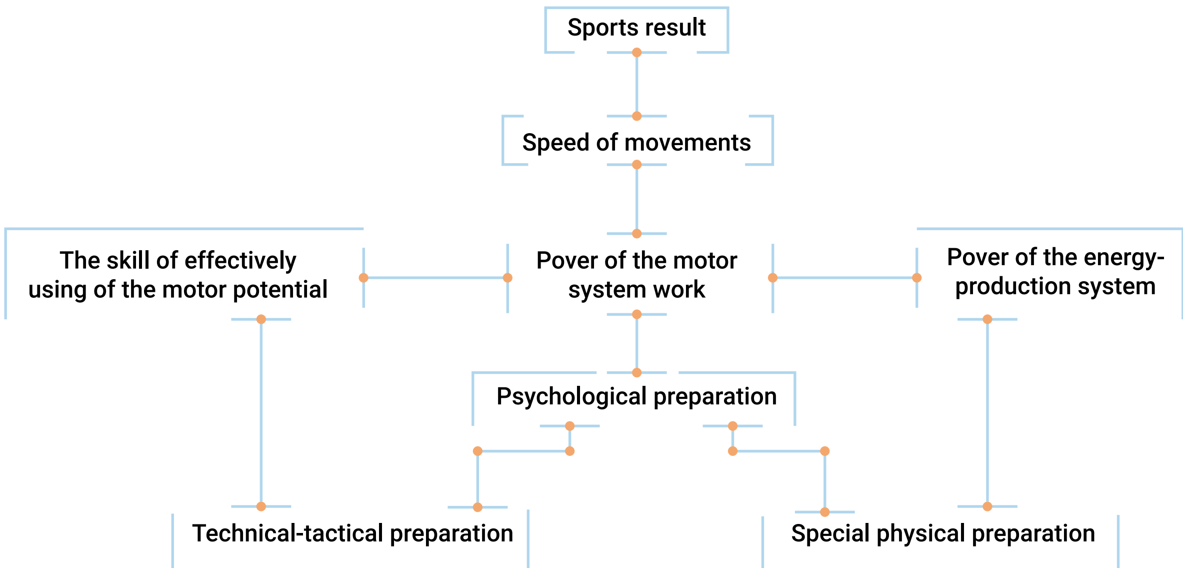


Figure 69. Constructs affecting sports results (substance ~ form model). Courtesy of Yuri Verkhoshansky. Taken from "Special Strength Training. A Practical Manual for Coaches. Moscow 2006"

If we use the car analogy, substance would be the car characteristics while form would be the driver's skill levels. Pretty much everything revolves around potential (substance, or special physical preparation in the above image) and realization of that potential (form, skill or technical-tactical preparation in the above image). This model is so ingrained in us that we are usually not aware of it. This is a very satisficing model, but sometimes it is flawed, especially when ***scientism*** tries to enforce their analytics-based constructs, rather than allowing for flexible, fractal-like and emergent qualities to be established continuously. This is the reason why I have introduced the Substance/Form element in my qualities model.

According to Yuri Verkhoshansky, as one's performance improves, the limiting factor becomes potential (Y. Verkhoshansky & Verkhoshansky, 2011):

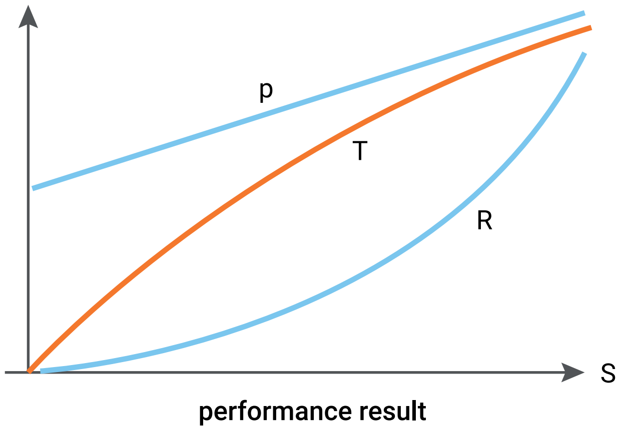


Figure 70. Relationship between potential and ability to utilize potential as performance improves. Courtesy of Yuri Verkhoshansky. Modified based on "Main Features of a Modern Scientific Sports Training Theory". Available at http://www.verkhoshansky.com/)

So according to this model, the bottle neck in performance is not the skill (or coordination, or form, or ability to use potential), but potential itself. But even being satisficing, this model is too simplistic and makes lab coats conclude that in order to increase performance one must improve the underlying, analytics-based constructs. And that is one of the reasons why coaches such as Raymond Verheijen (Verheijen, 2014) flipped out and started bitching at sport scientists. As I alluded to before, I believe that a phenomenological approach in determining the qualities and substance/form relationship is more important than analytical ones (performance and physiology based). Besides, one needs to realize that limiting factors are very hard to pinpoint and they are not as simple as ***A causes B*** (Pearl et al., 2016; Rohrer, 2018).

For example, even if you improve MAS or VO_2max, the running performance in a game might not improve. Even if it improves, it doesn't mean that the team will play better. There might also be a plateau phenomenon, where increasing potential costs too much (in terms of time and energy), without too much benefit in the realization (performance). Besides, maybe the needed level of potential can be achieved without doing HIT at all. Maybe the athletes can play their way into shape and that may be more than good enough.

These are all fair questions that introduce even more uncertainty. But we can't wait for the research to give us an answer so we need to rely on heuristics. In this case, the solution is again 1/N heuristic. To avoid being a sucker, some volume of HIT should be performed, even if you believe that playing your sport is more than enough to improve the levels of (specific) endurance.

But maybe the main reason to introduce HIT is not in increasing underlying potential, but increasing variety in the training program and achieving a higher level of robustness in the athletes as well as to correct for the loading fluctuations. Because playing small sided games (SSG) or medium, or large ones, creates a highly variable training load, HIT can be used to ***top-up*** and control for such fluctuations.

Let's assume that you follow Raymond Verheijen's (Verheijen, 2014) periodization for a soccer team. Raymond's approach calls for iterations between three phases that utilize different soccer games. At the same time, you might track external load over GPS for every individual player (for example, High Speed Distance - HSD and PlayerLoad2D, which are measures of high speed running and CODs). On the following picture there is a hypothetical scenario that happened over 6 weeks (3x2 weeks) for a single athlete:

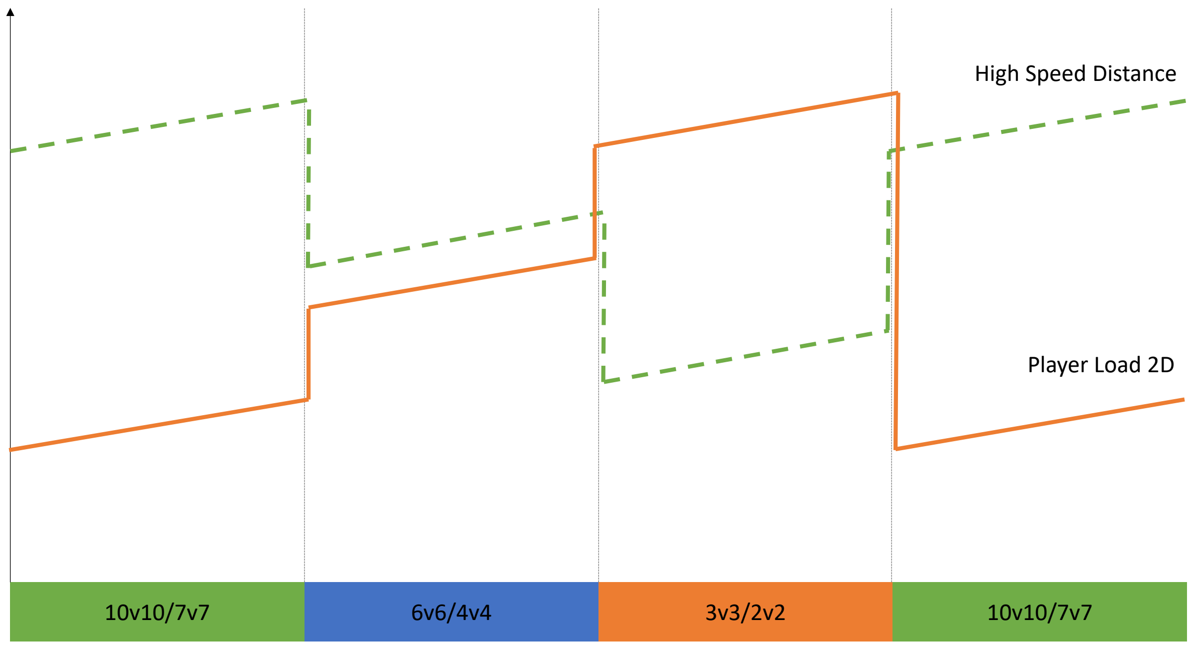


Figure 71. Rotating emphasis on large-, medium-, and small-sided games across weeks might result in fluctuations of high-speed and change-of-direction GPS metrics.

The sources of fluctuations in HSD and PlayerLoad2D might be due to variability in SSGs or, what is the case here, the switch in emphasis. Raymond introduced a concept of ***unload***, where the next phase is introduced in the previous phase using 50% of the planned load. This helps alleviate the load swings, but they still might happen (for example, an athlete might miss the SSG session). According to the research, one of the main reasons why injuries happen are huge swings in training load, especially from phase to phase (e.g. when you repeat the above cycle).

For this reason, a HIT workouts can serve two top-up purposes:

1. Top-Up Phase
2. Complement Top-Up

Top-Up Phase

For example, if we plan on overloading, at least from a physical standpoint, HSD using large sided games, due to normal variability (or even missed practices), some players might not achieve the needed numbers. By live tracking GPS, one can decide to either stop the drill or session, or that an extra top-up is needed. For this reason, long, straight HIT drills might be used (i.e. in the case of not enough of HSD being accumulated). The aim of the ***top-up phase*** is to fill the objectives of the phase (or sprint) in the case that the SSG doesn't manage to do so.

Complement Top-Up

Complement Top-Up is a version of the 1/N heuristic, or making sure that that all important bases are covered. For example, emphasizing SSGs might overload change of direction, but doesn't stimulate high speed running enough. In this case, HIT needs to do that. This way we are making sure there are no big swings in high speed distance over time, so once the HSD emphasis block comes (or happens), we are sure athletes are ready to withstand the training load.

These two approaches to HIT represent a non-traditional approach to HIT conditioning. But to do so, one needs live GPS tracking, which is not available in most clubs. When you can't do this type of ***responsive planning***, doing the best you can with ***pre-emptive*** planning might be more than enough and that involves performing both SSGs and some HIT conditioning to make sure all the important bases are covered.

When should it be done?

So far we have discussed ***what needs to be done***, now we need to figure out ***when it needs to be done***. There are multiple time scales at which things can happen, so let's start with a single session first.

Single session

Usually HIT conditioning is done at the end of the session, or in a ***block*** manner, but it can also be done in a ***distributed*** manner:

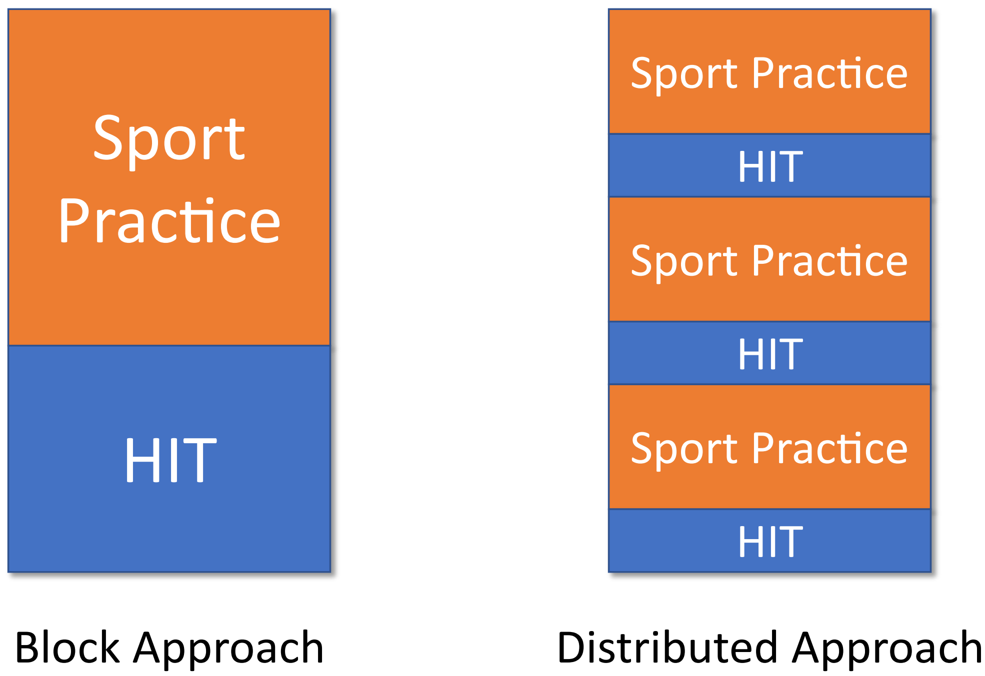


Figure 72. Block vs Distributed (or Random) approach to doing HIT conditioning within a session

The block approach creates more ***saturation*** and might be needed, although the distributed approach represents a viable solution than can be easily applied. For example, one group of athletes might perform a SSG and the other might do HIT. This can also work as a ***differential learning environment*** and can be used in conjunction with skill practice. For example, you might want to practice set pieces (e.g. corner kicks), but you want to practice them in a fatigued state, so you might create a representative learning environment by alternating offensive and defensive corners interspersed with some HIT conditioning.

In my experience, the distributed approach is much more ***fun*** (if hard HIT conditioning can be called fun), but harder to setup (it can sometimes be easier to set up and administer, for example, in a cold climate where it might be the only choice if not all athletes can play a SSG at the same time). The block approach is sometimes needed, as alluded, to create saturation (e.g. VO_2 will increase from set to set and thus might create a stronger stimulus).

One thing to keep in mind is that you do not need to stick to a single HIT drill for a given day (e.g. active long intervals). Different HIT drills can be performed in a distributed approach (which also helps in applying the 1/N heuristic):

1. Block #1: Passive Short Intervals
2. Block #2: Repeat Sprint Training
3. Block #3: Sprint Interval Training

Another way to utilize the ***randomization*** principle would be to use random changes in a given HIT drill (I've heard this suggestion by Dan Baker (Baker, 2011)) - For example, if you perform passive short intervals (PSI), one repetition could be 15sec (and 15sec break), the next could be 20sec, then 10sec, in a random order. This might be a viable strategy to use, since work-to-rest is never the same in real competition and we want athletes to be adaptable, not adapted. A similar approach is utilized in Charlie Francis's extensive tempo, where 100m and 200m intervals are used within one set. This makes an athlete adapt to more changeable work-to-rest work-ratios.

Week or sprint

Usually HIT is performed on certain ***optimal*** days, which can be constrained by the competition schedule (especially in team sports). For example, you can't do HIT on two days after the game (e.g. except Intermittent Recovery) or a day before a next game. In this example, you might be constrained to only a few days.

I once visited my friend, Israel Halperin, who is an outstanding researcher as well as Muay-Thai coach (and ex-competitor) at the AIS while he was doing his PhD there and coaching a Muay-Thai group. Every session he performed consisted of:

1. Warm-up
2. Technical work
3. Technical work with partner (or sparring like drills)
4. Conditioning (usually specific, on the bag, etc.)

I asked him why he doesn't have ***thematic days***, e.g. one day mostly technique work, one day hard conditioning and so forth. His answer got me thinking more and more about Agile applications. He responded that he cannot predict who is coming to practice and if someone misses a thematic day, he will miss it for a few days or even weeks. So, from an attendance uncertainty perspective, a distributed or mixed approach is better.

Derek Hansen introduced the term ***micro-loading*** (Hansen, 2015), which is nothing more than spreading a given work volume over multiple days rather than doing a chunk of it on a single or more days. Micro-loading is an outstanding approach that can be a great starting point in coaching athletes that increases the robustness of planning. A little bit of everything on every day. Optimal? No, but the most robust approach you can use is a launching pad for further experimentations.

You might wonder if this approach will increase training monotony. Maybe, maybe not. Using a micro-loading approach, you can still make certain workouts harder or easier, but probably even less boring if you create variations within ***buckets (i.e. qualities)***. This way you also keep athletes guessing, create interesting and varied workouts, and avoid making athletes adapted. The goal is to make athletes adaptable, not adapted. Again, this is a starting point (1/N, cover all the important bases, protect from the downside). Once this is achieved, you can play with reaping the upside. Maybe allowing for some practice time that is ***emergent*** (e.g. you leave 20min unplanned, as long as all bases are covered), which you can fill with anything you deem important or whatever manifests itself in the session and needs to be addressed in higher volume/detail. You can still have thematic days, as long as you address the 1/N heuristic.

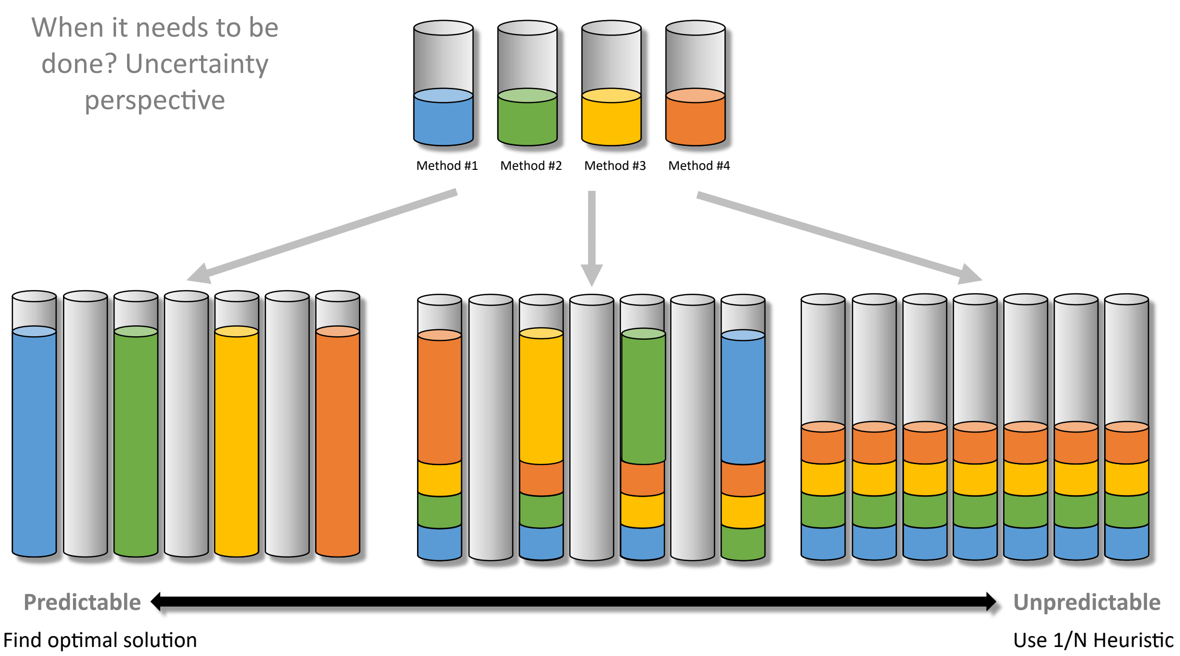


Figure 73. When things should be done? Answer depends on how predictable the scenario is we are dealing with

How can this be applied to HIT? Well, the easiest way might be to do 4x100m tempo strides at the end of every session. Over time, athletes will accumulate a lot of high speed distance and quality running without actually being aware. There is a saying that the best diet is the one you are not aware of. I think the same holds true for HIT conditioning - the best HIT conditioning is the one you are not aware of. Distributing a planned HIT volume in small chunks every day might be a strategy that achieves that. You can still have a blocked day with more volume of HIT once the opportunity emerges. And this happens a lot during real life strength and conditioning. You plan for HIT conditioning, the head coach decides he needs more time to address certain tactical issues and he ditches the HIT. If you have only one HIT session during an in-season week, it will take two weeks until you do that session again. And once you do, there is higher chance of inducing stress-related issues. So micro-loading works both for unpredictable athletes, situations, as well as head coaches.

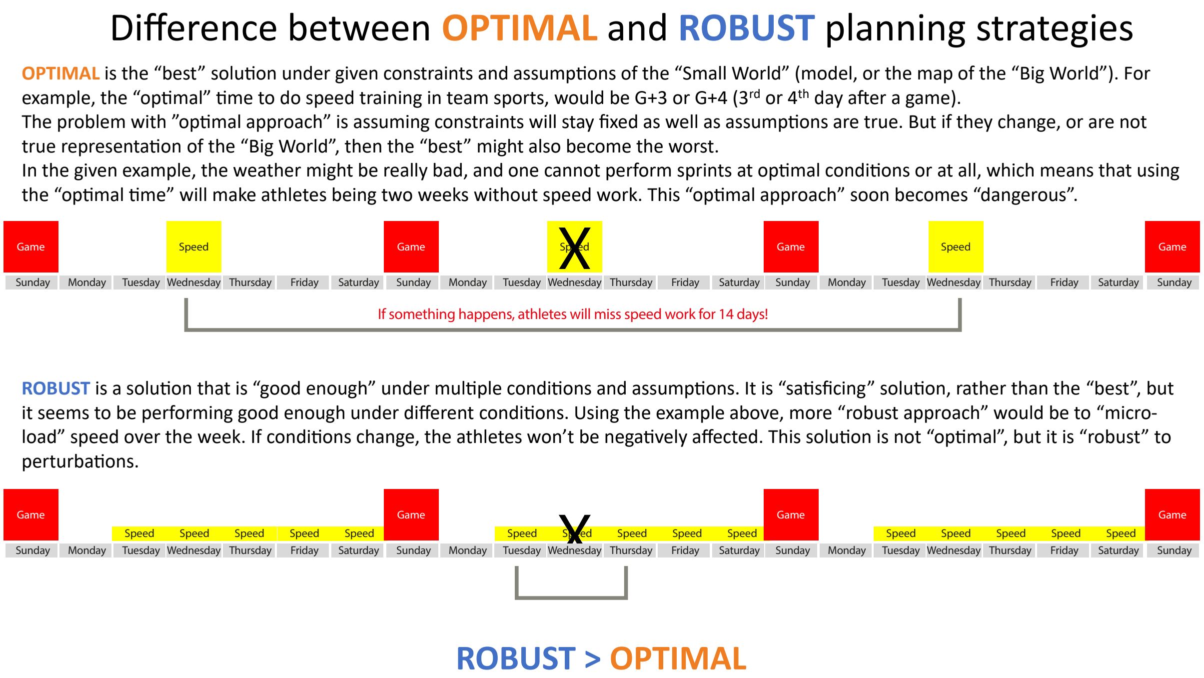


Figure 74. Difference between optimal and robust (micro-dosing) planning

Phases

As alluded in ***what to do***, using the 1/N heuristic, as well as creating emphasis (either following a certain pattern, randomly, individually, or using Top-Up strategies) is the most robust approach you can do. The objective #1 would be to make sure all the bases are covered (e.g. using the 1/N heuristic). After that, you are free to experiment

The concepts of ***what to do*** and ***when to do it*** represent the basis of **Agile Periodization**, which approach training planning not from physiological standpoint and trying to find the optimums, but rather from a complexity and uncertainty standpoint. These concepts are mostly applied to the whole training system, but can also be applied to individual training components, in this case, HIT conditioning.

Example HIT programs

Providing program examples is always tricky since there are a lot of assumptions involved and it is hard to make it usable in multiple scenarios with different objectives. But, as an avid reader of strength and conditioning literature, I always appreciated a sample program, regardless of its limited applicability in multiple scenarios. For this reason, I will provide a few generic examples (or should I call them ***minimum viable programs*** - MVP) for team sport athletes (mostly having soccer athletes in mind) that could be done during the off-season, pre-season and in-season. This will give you a starting point that you can use and modify to suit your objectives and context.

It is important to keep in mind that these programs should be put in context with other training components (skill and practices, strength, speed, power training and so forth) and these can vary a lot from case to case. It is beyond this HIT Manual to go too deep into overall program design and periodization that takes all training components into consideration.

Off-Season HIT Program

Playing your sport (in this case soccer) and SSGs (Small Sided Games) are always preferred methods of getting in game-shape. Unfortunately, sometimes that is not possible, nor preferable. For example, being a free-agent and wanting to get in shape, coming back from injury (although soccer practices are a key element of a good **RTP** – return to play – program), or during the off-season, where one wants to have a mental break from the ball and so forth.

For these reasons, I've designed a simple running program for running-based sports; something that you can use with your athletes during a break or to have in your toolbox and apply it, if needed, in the RTP protocols or as extra conditioning.

The program is based on four 2 to 3 week long training phases:

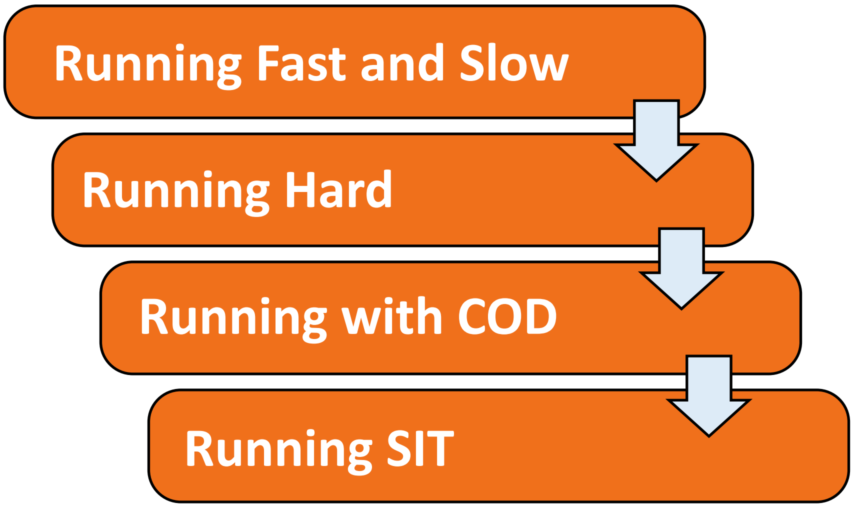


Figure 75. Phases of the Off-Season HIT Conditioning Program

Each training phase consists of 2 HIT workouts and 2 extensive runs, which are usually performed on Monday, Tuesday, Thursday and Friday, although the specific schedule depends on your context. During the off-season, where there are no team sport practices, it is important to accumulate volume of lower-intensity running together with HIT conditioning, ideally achieving a **polarized training distribution** (Fitzgerald, 2014; Seiler & Tønnessen, 2009; Solli, Tønnessen, & Sandbakk, 2017).

The following table contains the weekly workout content of each training phase.

Phase	Duration	Monday	Tuesday	Thursday	Friday
Running Fast and Slow	2-3 weeks	Tempo	Extensive Run	Tempo	Extensive Run
Running Hard	2-3 weeks	Intensive PLI	Extensive Run	Extensive ALI	Extensive Run
Running with COD	2-3 weeks	Extensive Run	Extensive ASI	Extensive Run	Intensive PSI
Running SIT	2-3 weeks	Extensive Run	SIT	Extensive Run	RST

Table 23. Weekly workout content of Off-Season HIT Conditioning program

Using this program will make sure that your athletes are coming ready-to-train from the off-season (or RTP), while providing individually tailored workouts that are not too boring to be performed.

Phase #1: Running Fast and Slow

If the name of this phase reminds you of Daniel Kahneman's book "Thinking Fast and Slow," you are right. The goal is to perform workouts from two opposite intensity extremes: slow and fast, achieving a strategy very similar to what Steve Magness described as ***funnel periodization*** (Magness, 2013).

Monday	**Tempo**
Tuesday	**Extensive Run**
Wednesday	
Thursday	**Tempo**
Friday	**Extensive Run**
Saturday	
Sunday	

Figure 76. Running Fast and Slow phase workouts

Tempo workouts will prepare you for the HIT workouts of the subsequent phase, while extensive runs will represent the bread and butter of your off-season conditioning program. You can look at this phase as ***base building***; something that will prepare you for the more strenuous, upcoming HIT conditioning.

Tempo workouts

Tempo runs are fast, quality runs done at a speed faster than 130% MAS (see the chapter on Tempo runs for more details). Repetition durations for these workouts are around 15-20sec with a rest period of 40-60sec.

The goal of this workout is to accumulate volume of faster, quality runs without draining your body. By using tempo runs you will be able to work on your running form and prepare your body for the hard runs to follow.

You can organize tempo runs by using time or distance. If you plan using time for running, you should stick to 15-20sec and if you plan on using distance, 80-120m will be fine (see chapter on Tempo runs for more details).

I will provide tempo workouts based on time, but you can quickly adjust by using distance instead (using HIT Builder). Here is the progression you can use:

Workout #1	3 sets of 6 reps of 15sec runs with 40sec rest
Workout #2	3 sets of 8 reps of 15sec runs with 40sec rest
Workout #3	3 sets of 10 reps of 15sec runs with 40sec rest
Workout #4	4 sets of 6 reps of 15sec runs with 30sec rest
Workout #5	4 sets of 8 reps of 15sec runs with 30sec rest
Workout #6	4 sets of 10 reps of 15sec runs with 30sec rest

Table 24. Tempo progression

During the recovery period, you can alternate between a core movement (15–20 reps) and push-ups (10–15 reps) if your shape allows you. Recovery between sets will be a little longer, around 2-3 minutes, during which you can perform basic stretching for the hip flexors, adductors, calves and hip rotators.

So the tempo workout might look like this:

10-15min Warm-up

15 sec Tempo run

Rest 40 sec and perform ab curl-ups for 20 reps

15 sec Tempo run

Rest 40 sec and perform push-ups for 10 reps

15 sec Tempo run

Rest 40 sec and perform side bridge for 20 reps

15 sec Tempo run

Rest 40 sec and perform push-ups for 10 reps

15 sec Tempo run

Rest 40 sec and perform low abs (scissors) for 20 reps

15 sec Tempo run

Rest 40 sec and perform push-ups for 10 reps

15 sec Tempo run

Rest 40 sec and perform dead bugs for 20 reps

15 sec Tempo run

Rest 40 sec and perform push-ups for 10 reps

End of set #1

Longer rest for 2-3 minutes *(perform a couple of stretches and/or dynamic moves like leg swings)*

Repeat 2 more times

Extensive Runs

To improve your endurance you need both intensive and extensive running (Fitzgerald, 2014; Magness, 2013; Seiler & Tønnessen, 2009; Solli Et Al., 2017). Extensive runs are going to be your bread and butter that we are going to keep doing through all training phases. You are also going to be able to modify this run to suit your preferences, but more on this later.

You are going to perform extensive runs in an interval fashion as well (which will make them a bit faster and on the border between LIT and MIT; see Endurance Map). Usually your extensive runs are performed at pace slower than 60-70% MAS. You can also go by feel or use a heart rate monitor (in this case, running at a heart rate lower than 80% HRmax or less than 140-160bpm). **When in doubt - go slower**. The goal is to polarize the running volume distribution and avoid the ***middle zone*** (see MIT in Endurance Map). Otherwise, the extensive runs will make you too tired for more intense HIT workouts. Having extensive runs in interval format makes this harder to achieve, so it bears repeating one more time: when in doubt - go slower.

In the following table you can find the progression for the first training phase:

Workout #1	3 reps of 8 minutes
Workout #2	3 reps of 9 minutes
Workout #3	3 reps of 10 minutes
Workout #4	3 reps of 11 minutes
Workout #5	3 reps of 12 minutes
Workout #6	3 reps of 13 minutes

Table 25. Extensive Run progression

During the recovery period between runs in the Running Fast and Slow training phase, you are going to perform the following bodyweight (BW) exercises:

- BW Squats
- BW Split squats
- BW Single Leg Dead Lifts
- Calf Raises

You are going to progress on these exercises as well during the workouts:

Workout #1	1 circuit of 8 reps each
Workout #2	1 circuit of 10 reps each
Workout #3	1 circuit of 12 reps each
Workout #4	2 circuit of 8 reps each
Workout #5	2 circuit of 10 reps each
Workout #6	2 circuit of 12 reps each

Table 26. Bodyweight circuit progression

You should be able to perform these back-to-back with no rest in under 3-4 minutes.

Thus, the workout looks like this:

10-15min Warm-up

***8 minute** run at a pace less than 60-70% MAS or less than 70-80% HRmax*

1 circuit of BW exercises

***8 minute** run*

1 circuit of BW exercises

***8 minute** run*

1 circuit of BW exercises

Stretch and cool-down

Phase #2: Running Hard

During phase two, we will continue performing extensive runs, but we will exchange tempo runs for long intervals (LIs):

Monday	**Intensive PLI**
Tuesday	**Extensive Run**
Wednesday	
Thursday	**Extensive ALI**
Friday	**Extensive Run**
Saturday	
Sunday	

Figure 77. Running Hard phase workouts

Intensive Passive Long Intervals (PLI)

The following table contains progressions for Intensive PLI running workout:

Workout #1	8 x 1 min @100-110% MAS + 2 min walk
Workout #2	10 x 1 min @100-110% MAS + 2 min walk
Workout #3	12 x 1 min @100-110% MAS + 2 min walk

Table 27. Intensive Passive Long Intervals progression

You can select other variations from the HIT drills table (e.g. 2min run, 4min walk) if it suits you, just make sure to adjust the volume and number of reps. The progression is in performing more reps, and hence getting more volume across workouts.

If you have access, you should perform **hill bounds** before and after the intensive PLI workout. The bounds can be done on a steep hill for 30-40m, two to four times before and after the runs. They should be nice and bouncy, with great relaxation. If you don't have access to a hill, you can do them on a flat surface (grass). The workout could look like this:

10-15 min warm-up

2-4 Hill Bounds (30-40m)

8 x 1 min @100-110% MAS + 2 min walk

2-4 Hill Bounds (30-40m)

Core & Stretch

Extensive Active Long Intervals (ALI)

The following table contains progressions for Extensive ALI:

Workout #1	6 x 2 min @80-90% MAS + 1 min jog @50-60% MAS
Workout #2	7 x 2 min @80-90% MAS + 1 min jog @50-60% MAS
Workout #3	8 x 2 min @80-90% MAS + 1 min jog @50-60% MAS

Table 28. Extensive Active Long Intervals progression

Similar to Intensive PLIs, you can select other variations from the HIT drills table, but make sure to adjust the total volume.

Before this workout you should perform 40-60m **hill sprints** (or strides up to 80-90% effort) for two to four reps (with 2-3 minutes recovery) after a good warm-up and at the end of the workout.

10-15 min warm-up

2-4 Hill Sprints (40-60m)

6 x 2 min @80-90% MAS + 1 min jog @50-60% MAS

2-4 Hill Sprints (40-60m)

Core & Stretch

Extensive Runs

Extensive runs in phase two will continue the progression from the Phase 1:

Workout #1	4 reps of 8 minutes
Workout #2	4 reps of 9 minutes
Workout #3	4 reps of 10 minutes
Workout #4	4 reps of 11 minutes
Workout #5	4 reps of 12 minutes
Workout #6	4 reps of 13 minutes

Table 29. Extensive Run progression

During the recovery period between runs, you are going to perform the following bodyweight (BW) exercises:

- BW jump squats
- BW Lunges
- BW Single Leg Dead Lifts
- Calf Raises

You are going to progress on these exercises as well during the workouts:

Workout #1	1 circuit of 8 reps each
Workout #2	1 circuit of 10 reps each
Workout #3	1 circuit of 12 reps each
Workout #4	2 circuits of 8 reps each
Workout #5	2 circuits of 10 reps each
Workout #6	2 circuits of 12 reps each

Table 30. Bodyweight circuit progression

You should be able to perform these back-to-back with no rest in under 3-4 minutes.

Thus, the workout looks like this:

10-15min Warm-up

8 minute run *at a pace less than 60-70% MAS or less than 70-80% HRmax*

1 circuit of BW exercises

8 minute run

1 circuit of BW exercises

8 minute run

1 circuit of BW exercises

8 minute run

1 circuit of BW exercises

Stretch and cool-down

Phase #3: Running with COD

The end of the Phase 2 might be a good time to retest your MAS (and MSS) and use updated speeds (or slightly increased values - e.g. 0.07 m/s to 0.14 m/s, or 0.25 to 0.5 km/h) for the next two phases.

In Phase 3, I have switched Extensive Runs and HIT conditioning workouts:

Monday	**Extensive Run**
Tuesday	**Extensive ASI**
Wednesday	
Thursday	**Extensive Run**
Friday	**Intesive PSI**
Saturday	
Sunday	

Figure 78. Running with COD phase workouts

The main reason for this switch is that hill sprints and hill bounds will be done on Extensive Runs (e.g. one day perform bounds and one day sprints), rather than on HIT conditioning workouts (although, if you prefer to perform them on HIT days, you are welcome to do so). You can also perform flat sprints to make an easier transition to the SIT and RST workouts in Phase 4.

Extensive Runs

Extensive runs in Phase 3 will continue their progression from Phase 2:

Workout #1	3 reps of 15 minutes
Workout #2	3 reps of 16 minutes
Workout #3	3 reps of 17 minutes
Workout #4	3 reps of 18 minutes
Workout #5	3 reps of 19 minutes
Workout #6	3 reps of 20 minutes

Table 31. Extensive Runs progression

Between intervals, you are going to perform the following exercises:

- BW Burpees (half the number of reps of the other exercises; 4-6)
- BW scissor jumps
- BW Skaters
- Calf Raises

You are going to progress on these exercises as well during the workouts:

Workout #1	1 circuit of 8 reps each
Workout #2	1 circuit of 10 reps each
Workout #3	1 circuit of 12 reps each
Workout #4	2 circuits of 8 reps each
Workout #5	2 circuits of 10 reps each
Workout #6	2 circuits of 12 reps each

Table 32. Bodyweight circuit progression

You should be able to perform these back-to-back with no rest in under 3-4 minutes.

The only addition to Extensive Runs are hill sprints that are performed at the beginning and the end of the workout.

Thus, the workout looks like this:

10-15min Warm-up

2-4 Hill Sprints *(40-60m)*

15 minute run *at a pace less than 60-70% MAS or less than 70-80% HRmax*

1 circuit of BW exercises

15 minute run

1 circuit of BW exercises

15 minute run

2-4 Hill Sprints *(40-60m)*

Stretch and cool-down

Extensive Active Short Intervals (ASI)

In Phase 3, you are going to perform short HIT conditioning drills in shuttle arrangements (i.e. at least one change of direction; COD).

The following table contains progressions for Extensive ASI:

Workout #1	4 x 8 x 30sec @90-100% MAS + 15sec @50-60% MAS
Workout #2	4 x 9 x 30sec @90-100% MAS + 15sec @50-60% MAS
Workout #3	4 x 10 x 30sec @90-100% MAS + 15sec @50-60% MAS

Table 33. Extensive Active Short Intervals progression

You can select other variations from the HIT drills table, but make sure to adjust the total volume. Using HIT Builder, calculate the shuttle distances.

Intensive Passive Short Intervals (PSI)

The following table contains progressions for Intensive PSI:

Workout #1	4 x 8 x 15 sec @120-130% MAS + 30sec passive
Workout #2	4 x 9 x 15 sec @120-130% MAS + 30sec passive
Workout #3	4 x 10 x 15 sec @120-130% MAS + 30sec passive

Table 34. Intensive Short Passive Intervals progression

You can select other variations from the HIT drills table, but make sure to adjust the total volume. Using HIT Builder, calculate the shuttle distances.

Phase #4: Running SIT

Phase 4 is the final phase of this off-season HIT program and it is the most stressful since it contains SIT and RST workouts.

Monday	**Extensive Run**
Tuesday	**SIT**
Wednesday	
Thursday	**Extensive Run**
Friday	**RST**
Saturday	
Sunday	

Figure 79. Running SIT phase workouts

The short intervals, as well as the hill and flat sprints from Phase 3, should have prepared you for SIT and RST workouts. But even with having done those workouts, progress to SIT and RST carefully and conservatively.

Sprint Interval Training

As stated in the SIT chapter, the best progression for SIT drills might be to go from an extensive version with more CODs (which doesn't allow for faster velocities to be reached) to a more intensive version with less CODs or in a straight line. The following table contains a potential progression for the SIT workouts:

Workout #1	2 x 4 x 15sec SIT with 4 CODs (3 min break)
Workout #2	2 x 4 x 20sec SIT with 3 CODs (4 min break)
Workout #3	2 x 4 x 25sec SIT with 2 CODs (5 min break)

Table 35. Sprint Interval Training progression

Repeat Sprint Training

The following table contains a progression for RST running workouts:

Workout #1	3 x 10 x 20m sprint with 20 sec rest
Workout #2	3 x 8 x 20m sprint with 15 sec rest
Workout #3	3 x 6 x 20m sprint with 10 sec rest

Table 36. Repeat Sprint Training progression

As you can see, this is a simple, ***linear*** strategy, progressing from more reps and more recovery time, to fewer reps and shorter recovery times.

Both SIT and RST workouts can be preceded and followed with more extensive running as shown below:

10-15min Warm-up

10-15min Extensive Run

SIT or RST workout

10-15min Extensive Run

Stretch and cool-down

Extensive Runs

Progressions for Extensive Runs in Phase 4 can be found in the following table:

Workout #1	2 reps of 25 minutes
Workout #2	2 reps of 27 minutes 30 seconds
Workout #3	2 reps of 30 minutes
Workout #4	1 rep of 50 minutes
Workout #5	1 rep of 55 minutes
Workout #6	1 rep of 60 minutes

Table 37. Extensive Runs progression

Due to the use of SIT and RST workouts, there will be no need to perform hill sprints nor bounds, but it you feel like it, you can perform them before and/or after extensive runs.

Between intervals (or before/after for one rep intervals) you are going to perform the following exercises:

- BW Burpees (half the number of reps of the other exercises; 4-6)
- BW scissor jumps
- BW Skaters
- Calf Raises

The following table contains progressions for the BW circuit:

Workout #1	3 circuits of 8 reps each
Workout #2	3 circuits of 10 reps each
Workout #3	3 circuits of 12 reps each
Workout #4	4 circuits of 8 reps each
Workout #5	4 circuits of 10 reps each
Workout #6	4 circuits of 12 reps each

Table 38. Bodyweight Circuit progression

Modifications of the Off-Season program

When it comes to HIT workouts, the easiest modification would be to use other intervals from the same "bucket" (i.e. use 20:10 vs 30:15 for Extensive Active Short Intervals).

For the extensive runs, you can just go for longer runs (20-60 minutes) rather than following the interval progressions. Another option for those wanting to perform low-impact conditioning (except jump rope) is to do the following circuit:

- 5 min bike
- 5 min rower
- 5 min jump rope

Try to keep your HR around 80% HRmax or within 140-160bpm. Working out your upper body muscles (rowing, cross-trainer, airdyne bikes) might help with metabolizing "byproducts" of higher intensity efforts that are distributed from working muscles (legs) and hence represent viable conditioning options.

These off-legs options can be performed for HIT workouts as well (e.g. rowing, battle-ropes), but prescribing the exact intensity (power, velocity) will be more involved and might demand testing MAS for specific equipment. In that case, you can rely on your subjective indicators (e.g. RPE).

Pre-Season and In-Season Program

When it comes to team sports planning strategies, I like to utilize two concepts: (1) functional groups and (2) mini-blocks (Jovanović, 2017a; 2017b). It is beyond this manual to go into details regarding planning strategies and the mentioned concepts, but for the sake of example I will provide some clarification.

Functional groups represent ***teams within a team*** that a coach needs to take into account and create separate plans for. Functional groups are mostly related to game availability:

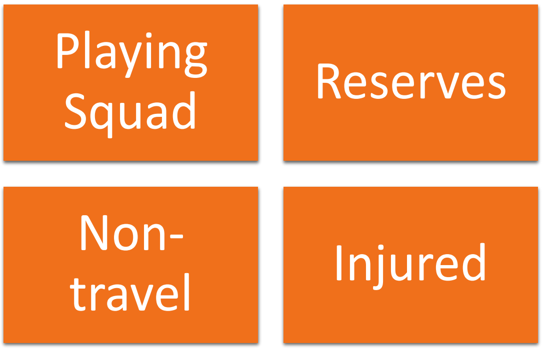


Figure 80. Functional Groups

In an ideal world, coaches should provide individual plans, but in real life these four groups are more than enough. The **Playing Squad** is related to athletes who are starting the game and who play more than 60 minutes (which is the usual threshold in soccer to be considered in the Playing Squad functional group). **Reserves** are players who traveled for the game and who are on the official match list (in soccer, that is usually 7 athletes - 6 players and 1 goal keeper). **Non-travel** are athletes who didn't travel for the game and are available for extra training. **Injured** are athletes who are in a ***return-to-play*** (RTP) protocol and demand special attention. An extra group that is usually added is **Other**, which might include athletes who are away on a break or leave, borrowed to another club or have national team obligations.

These groups are dynamic and athletes move from these functional groups from game to game.

Mini-blocks represent building blocks of the microcycle (which is the period between two games):

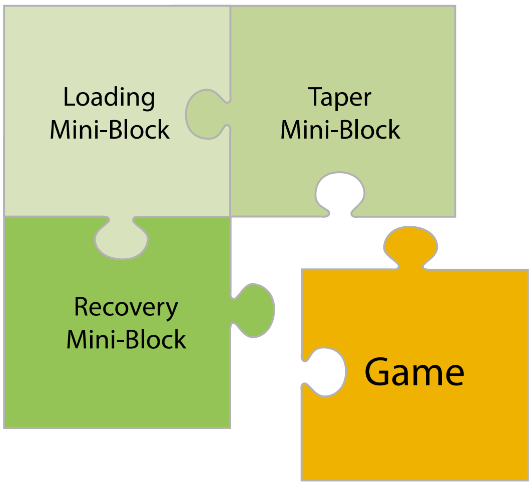


Figure 81. Mini-Blocks

These mini-blocks are laid in order: (1) recovery mini-block, (2) taper mini-block and, if there is some time left, (3) loading mini-block. These are planned for separately for the above functional groups. As already stated, it is beyond this manual to go into more details regarding planning strategies for team sports and interested readers are directed to the following references: (Jovanović, 2017a; 2017b; Mallo & Sanz, 2014; Verheijen, 2014).

The following figure contains implementation of functional groups and mini-blocks for one ordinary microcycle (Sunday-Sunday game). The outlined Thursday represents a day where the likelihood of the most strenuous conditioning will take place.

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Last Game	G+0	G+1	G+2	G+3	G+4	G+5	G+6	G+7
Next Game	G-7	G-6	G-5	G-4	G-3	G-2	G-1	G-0
Playing Squad	Game	Recovery	Recovery	Loading	Loading	Taper	Taper	Game
Reserves	Game	Loading	Recovery	Loading	Loading	Taper	Taper	Game
Non-Travel	Loading	Loading	Recovery	Loading	Loading	Loading	Taper	Loading
Injured	Loading	Loading	Recovery	Loading	Loading	Recovery	Loading	Loading

Legend

Game
Loading Mini-Block
Taper Mini-Block
Recovery Mini-Block

Figure 82. One ordinary microcycle plan using functional groups and mini-blocks

When it comes to conditioning, the aim is to do most of it with the ball using large-sided, medium-sided and small-sided games. HIT conditioning is complementary to these, and if one is equipped with GPS devices, a Top-up approach (complement and phase) to conditioning can be utilized instead.

The example program in this manual is modified from Raymond Verheijen's program (Verheijen, 2014). Raymond uses an iterative, three-phase plan, in which he rotates large-sided, medium-sided and small-sided games. He also utilizes an ***unload*** (which is around 50% of load) of the upcoming phase. As stated previously, this helps in smoothing out potential spikes in load. Although soccer-specific conditioning is the primary mean for conditioning, complementary HIT conditioning is added to make sure all important boxes are ticked off all the time:

Phase	**Phase 1**					
Subphase	**10v10-7v7**		**6v6-4v4**		**3v3-2v2**	
Microcycle	1	2	3	4	5	6
Large Sided Games	**3x12'**	**3x13'**			3x6'30''	3x6'30''
Medium Sided Games	4x2'	4x2'	**4x5'**	**4x5'30''**		
Small Sided Games			6x1':3'	6x1':3'	**2x6x1':3'**	**2x6x1':2'30''**
Speed/Power	1v1/Hill/Sled 10-30m		1v1/Flat 20-50m		1v1/Flat 30-60m FEF	
Long Intervals			Passive with COD /shorter		**Active without COD / longer**	
Short Intervals	**Passive with COD**				Active without COD + Tempo	
SIT/RST	Extensive with COD		**Intensive without COD**			
Top-Up (Phase)	High Speed Running			COD/Accel/Deccel		
Top-Up (Complement)	COD/Accel/Deccel			High Speed Distance		

Figure 83. One iteration of HIT Conditioning In-Season program

By utilizing complementary HIT conditioning, training aspects that are not covered with soccer-specific conditioning are covered with HIT conditioning (i.e. in 10v10-7v7 phase, one needs to cover more COD type of conditioning and in 3v3-2v2 phase, one needs to cover more straight line, high speed HIT conditioning). This aspect is also covered with the Speed/Power conditioning component.

These are ***pre-emptive*** approaches (unload soccer-specific approach and complementary HIT conditioning), although a GPS monitoring-based, Top-Up approach can be used as well (see the figure above).

The above phases can be done over a week or two (i.e. one iteration lasts 3 to 6 weeks) and are linked together with a progression (for more details see Verheijen, 2014):

Phase	Phase 1						Phase 2					
Subphase	10v10-7v7		6v6-4v4		3v3-2v2		10v10-7v7		6v6-4v4		3v3-2v2	
Microcycle	1	2	3	4	5	6	1	2	3	4	5	6
Large Sided Games	**3x12'**	**3x13'**			3x6'30''	3x6'30''	**3x13'**	**3x14'**			3x7'	3x7'
Medium Sided Games	4x2'	4x2'	**4x5'**	**4x5'30''**			4x2'30''	4x2'30''	**4x5'30''**	**4x6'**		
Small Sided Games			6x1':3'	6x1':3'	**2x6x1':3'**	**2x6x1':2'30''**			6x1':2'30''	6x1':2'30''	**2x6x1':2'30''**	**2x6x1':2'**
Speed/Power	1v1/Hill/Sled 10-30m		1v1/Flat 20-50m		1v1/Flat 30-60m FEF		1v1/Hill/Sled 10-30m		1v1/Flat 20-50m		1v1/Flat 30-60m FEF	
Long Intervals			Passive with COD /shorter		**Active without COD / longer**				Passive with COD /shorter		**Active without COD / longer**	
Short Intervals	**Passive with COD**				Active without COD + Tempo		**Passive with COD**				Active without COD + Tempo	
SIT/RST	Extensive with COD		**Intensive without COD**				Extensive with COD		**Intensive without COD**			
Top-Up (Phase)	High Speed Running			COD/Accel/Deccel			High Speed Running			COD/Accel/Deccel		
Top-Up (Complement)	COD/Accel/Deccel			High Speed Distance			COD/Accel/Deccel			High Speed Distance		

Figure 84. Two iterations of in-season HIT Conditioning program linked together

In my opinion, there shouldn't be any major difference between pre-season and in-season planning (especially since pre-season is quite short in European soccer and multiple friendly games are planned for). For this reason, they are considered together, although a specific case of the above iterative plan can be utilized (called a ***Lead-In*** phase):

Phase	**Lead-in**					
Subphase	**10v10-7v7**		**6v6-4v4**		**3v3-2v2**	
Microcycle	1	2	3	4	5	6
Large Sided Games	**3x12'**	**3x13'**			3x6'30"	3x6'30"
Medium Sided Games	4x2'	4x2'	**4x5'**	**4x5'30"**		
Small Sided Games			6x1':3'	6x1':3'	**2x6x1':3'**	**2x6x1':2'30"**
Speed/Power	Strides/Bounds/Hills		1v1/Flat 20-50m		1v1/Flat 30-60m FEF	
Long Intervals	Active without COD		**Passive with COD**		Active without COD	
Short Intervals	**Tempo**		Active with COD		**Passive without COD + Tempo**	
SIT/RST						
Top-Up (Phase)	High Speed Running			COD/Accel/Deccel		
Top-Up (Complement)	COD/Accel/Deccel			High Speed Distance		

Figure 85. Lead-in phase for Pre-Season

As can be seen from the above figure, Lead-In is characterized by the lack of SIT/RST conditioning. This Lead-In phase can be done during the pre-season and then normal phases, as outlined before, can be implemented (with either 2 week or 1 week cycle length).

The following figure contains a potential weekly plan, taking everything written into consideration:

Legend

Game
Loading Mini-Block
Taper Mini-Block
Recovery Mini-Block

Last Game	G+0	G+1	G+2	G+3	G+4	G+5	G+6	G+7
Next Game	G-7	G-6	G-5	G-4	G-3	G-2	G-1	G-0
	Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Playing Squad	**Game**	Recovery	Recovery	Loading	Loading	Taper	Taper	**Game**
Reserves	**Game**	Loading	Recovery	Loading	Loading	Taper	Taper	**Game**
Non-Travel	Loading	Loading	Recovery	Loading	Loading	Loading	Taper	Loading
Injured	Loading	Loading	Recovery	Loading	Loading	Recovery	Loading	Loading

Playing Squad	**Game**	Intermittent Recovery		**Technical** (optional HIT secondary, SSG underload)	**Conditioning** SSG (primary) HIT (primary)	**Tactical** (optional HIT secondary, SSG underload)	**Tactical**	**Game**
Reserves	**Game**	**Conditioning** SSG (underload) HIT (primary)		**Technical** (optional HIT secondary, SSG underload)	**Conditioning** SSG (primary) HIT (primary)	**Tactical** (optional HIT secondary, SSG underload)	**Tactical**	**Game**
Non-Travel	**Conditioning** HIT (secondary, ind)	**Conditioning** SSG (underload) HIT (primary)		**Technical** (optional HIT secondary, SSG underload)	**Conditioning** SSG (primary) HIT (primary)	**Tactical** (optional HIT secondary, SSG underload)	**Tactical**	**Conditioning** HIT (secondary, ind)
Injured	**Conditioning** HIT (secondary, ind)	**Conditioning** SSG (underload) HIT (primary)		**Technical** (optional HIT secondary, SSG underload)	**Conditioning** SSG (primary) HIT (primary)	Pool recovery Off	**Conditioning** HIT (primary, ind)	**Conditioning** HIT (secondary, ind)

Figure 86. Daily content of the ordinary microcycle HIT Conditioning program

The Non-Travel and Injured functional groups can also afford individualized HIT conditioning (indicated by ***ind*** on the figure).

Micro-dosing approach to in-season and pre-season conditioning

To make things even simpler, utilization of the ***micro-loading*** principle can be implemented. This means doing some conditioning daily (usually tempo strides) in a micro-dose. This includes speed work, HIT conditioning and strength training. The potential distribution of HIT conditioning and/or micro-dosing in a single session is depicted on the following figure:

Indoor	Individual warm-up/prehab Strength circuit (4-6 exercises)
	Group warm-up 3-4x10-30m sprint Explosive exercise (1-2 sets of 4-6 reps)
Field	**Technical work** 3-4x20-50m sprint Explosive exercise (1-2 sets of 4-6 reps)
	Tactics 3-5x100m Strides + Core (or HIT)
	Tactics/SSG 3-5x100m Strides + Core (or HIT)
Indoor	**Strength Training** (1-2 exercises, 2-3 sets x 3-10 reps) Stretch

Figure 87. Micro-dosing approach to HIT Conditioning program

The session can start with an individualized prehab circuit indoor or it can involve some kind of basic strength circuit (e.g. bodyweight, slideboard, gymnastic rings, medicine balls). This is followed by the specific warm-up on the pitch (e.g. rondo, passing circuit) and finishes with some speed work (e.g. tags, relays, ground starts) and explosive exercises (e.g. jumps, throws). Longer sprints can be performed after technical work when athletes are really warm. Some HIT conditioning (or micro-dosing using tempo strides) can be distributed throughout the main part of the session and at the end. Very minimalistic strength training can be performed at the end of the session.

This micro-dosing approach is the simplest, yet most robust conditioning and physical preparation program you can utilize. This ***pre-emptive*** (i.e. planned in advance) HIT conditioning can be easily made more ***reactive*** by utilizing live GPS monitoring and implementing a Top-Up approach to conditioning (e.g. making sure athletes cover an individualized high speed distance if they do not achieve it in the skill component of training).

Conclusion

One can easily get lost in the physiological complexities of the endurance world as well as in planning strategies. The aim of this HIT manual was to simplify HIT conditioning and planning, provide a general overview, as well as to provide a simple tool coaches can use – HIT Builder. I am hoping that this goal is reached and that this manual represents a useful handbook that you can use in day-to-day coaching to help in planning and prescribing HIT conditioning. I am also hoping that provided HIT conditioning programs offers a good starting point in creating your own variations.

Go to www.hitbuilder.net to download HIT Builder and the shuttle-run beep test as well as to keep up to date in HIT conditioning. I wish you hard and smart training.

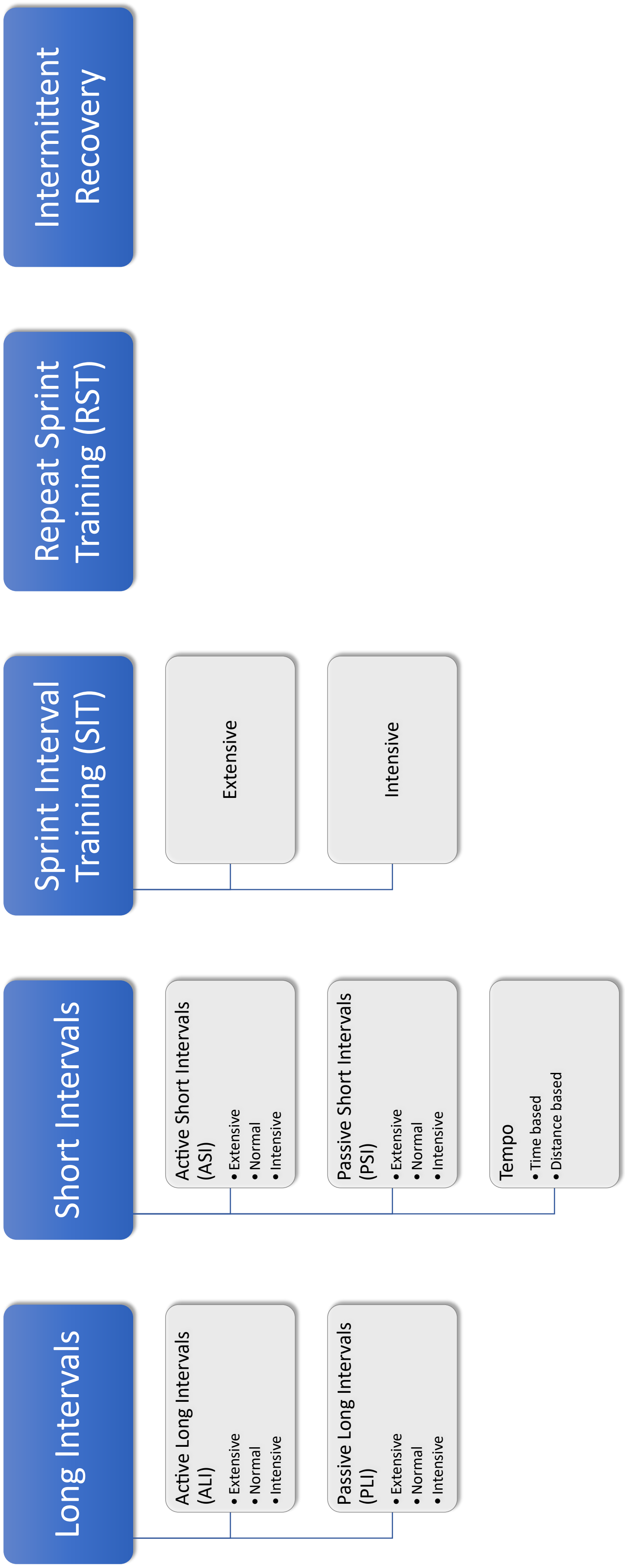
Sheets

The following pages contain sheets that you can print and use as quick reference guide.

Velocity (km/h)	% MSS	% ASR	Tlim (sec)	% MAS	HR (bpm)	% HRmax	% HRres	% VIFT	% vLT	% LTHR	bLA (mmol)	Thresholds
35	100%	100%	0 sec	194%				167%	233%			MSS
34.5	99%	97%	2 sec	192%				164%	230%			
34	97%	94%	5 sec	189%				162%	227%			
33.5	96%	91%	7 sec	186%				160%	223%			
33	94%	88%	10 sec	183%				157%	220%			
32.5	93%	85%	12 sec	181%				155%	217%			
32	91%	82%	15 sec	178%				152%	213%			
31.5	90%	79%	18 sec	175%				150%	210%			
31	89%	76%	21 sec	172%				148%	207%			
30.5	87%	74%	24 sec	169%				145%	203%			
30	86%	71%	27 sec	167%				143%	200%			
29.5	84%	68%	30 sec	164%				140%	197%			Wingate
29	83%	65%	33 sec	161%				138%	193%			
28.5	81%	62%	37 sec	158%				136%	190%			
28	80%	59%	41 sec	156%				133%	187%			
27.5	79%	56%	45 sec	153%				131%	183%			
27	77%	53%	49 sec	150%				129%	180%			
26.5	76%	50%	53 sec	147%				126%	177%			
26	74%	47%	58 sec	144%				124%	173%			
25.5	73%	44%	63 sec	142%				121%	170%			
25	71%	41%	68 sec	139%				119%	167%			
24.5	70%	38%	74 sec	136%				117%	163%			
24	69%	35%	80 sec	133%				114%	160%			
23.5	67%	32%	87 sec	131%				112%	157%			
23	66%	29%	94 sec	128%				110%	153%			
22.5	64%	26%	102 sec	125%				107%	150%			
22	63%	24%	111 sec	122%				105%	147%			
21.5	61%	21%	122 sec	119%				102%	143%			
21	60%	18%	133 sec	117%				100%	140%			VIFT
20.5	59%	15%	147 sec	114%				98%	137%			
20	57%	12%	165 sec	111%				95%	133%			
19.5	56%	9%	187 sec	108%				93%	130%			
19	54%	6%	218 sec	106%				90%	127%			
18.5	53%	3%	271 sec	103%				88%	123%			
18	51%	0%	4-8min	100%	200	100%	100%	86%	120%	114%	>10 mmol	vVO2peak / MAS
17.5	50%			97%	196	98%	97%	83%	117%	112%		
17	49%			94%	192	96%	94%	81%	113%	110%		
16.5	47%		15-20min	92%	188	94%	92%	79%	110%	107%	5-6 mmol	Critical Velocity
16	46%			89%	183	92%	89%	76%	107%	105%		
15.5	44%			86%	179	90%	86%	74%	103%	102%		
15	43%		40-60min	83%	175	88%	83%	71%	100%	100%	4 mmol	Anaerobic Threshold
14.5	41%			81%	171	85%	81%	69%	97%	98%		
14	40%			78%	167	83%	78%	67%	93%	95%		
13.5	39%			75%	163	81%	75%	64%	90%	93%		
13	37%			72%	158	79%	72%	62%	87%	90%		
12.5	36%			69%	154	77%	69%	60%	83%	88%		
12	34%			67%	150	75%	67%	57%	80%	86%	2 mmol	Aerobic Threshold
11.5	33%			64%	146	73%	64%	55%	77%	83%		
11	31%			61%	142	71%	61%	52%	73%	81%		
10.5	30%			58%	138	69%	58%	50%	70%	79%		
10	29%			56%	133	67%	56%	48%	67%	76%		
9.5	27%			53%	129	65%	53%	45%	63%	74%		
9	26%			50%	125	63%	50%	43%	60%	71%		
8.5	24%			47%	121	60%	47%	40%	57%	69%		
8	23%			44%	117	58%	44%	38%	53%	67%		
7.5	21%			42%	113	56%	42%	36%	50%	64%		
7	20%			39%	108	54%	39%	33%	47%	62%	1 mmol	Walking Threshold

Velocity (km/h)	Intensity Zones	Domains	Endurance Methods	HIIT Methods	Energy System	Fibers	RPE
35	HIT	Extreme	Neuromuscular Power	RST	Alactic Phosphagen	Fast Twitch	10
34.5							
34							
33.5							
33							
32.5							
32							
31.5				SIT	Anaerobic Glycolitic		
31							
30.5							
30							
29.5							
29							
28.5							
28							
27.5							
27							
26.5							
26				Tempo			
25.5							
25							
24.5							
24							
23.5							
23				Short Intervals			
22.5			Anaerobic Capacity				9
22							
21.5							
21							
20.5							
20							
19.5							
19			VO2max Intervals	Long Intervals			8
18.5							
18					Mixed Zone		
17.5		Severe					
17							
16.5							
16							
15.5		Heavy	Threshold				7
15							
14.5	MIT	Moderate		Active Recovery	Aerobic mitochondrial respiration	Slow Twitch	
14			Sweet Spot				6
13.5							
13			Intensive Endurance				5
12.5							
12							
11.5	LIT		Extensive Endurance				3
11							
10.5							
10							
9.5							
9			Active Recovery		Aerobic Fat Burning		1
8.5							
8							
7.5							
7							

Velocity	%MSS	%ASR	Tlim	Dist	%VIFT	%MAS	
9.00	100%	100%	0 sec	0 m	177%	203%	MSS
8.77	97%	95%	4 sec	35 m	173%	198%	
8.54	95%	90%	8 sec	69 m	168%	192%	
8.32	92%	85%	13 sec	104 m	164%	187%	
8.09	90%	80%	17 sec	139 m	159%	182%	
7.86	87%	75%	22 sec	174 m	155%	177%	
7.63	85%	70%	27 sec	209 m	150%	172%	
7.40	82%	65%	33 sec	245 m	146%	167%	
7.18	80%	60%	39 sec	282 m	141%	162%	
6.95	77%	55%	46 sec	320 m	137%	156%	
6.72	75%	50%	53 sec	358 m	132%	151%	
6.49	72%	45%	61 sec	399 m	128%	146%	
6.26	70%	40%	70 sec	442 m	123%	141%	
6.04	67%	35%	81 sec	487 m	119%	136%	
5.81	65%	30%	93 sec	538 m	114%	131%	
5.58	62%	25%	107 sec	595 m	110%	126%	
5.35	59%	20%	124 sec	663 m	105%	121%	
5.12	57%	15%	146 sec	748 m	101%	115%	VIFT
4.90	54%	10%	177 sec	867 m	96%	110%	
4.67	52%	5%	230 sec	1076 m	92%	105%	
4.44	49%	0%	4-8min		88%	100%	MAS
4.22	47%				83%	95%	
4.00	44%				79%	90%	
3.77	42%				74%	85%	
3.55	39%				70%	80%	
3.33	37%				66%	75%	
3.11	35%				61%	70%	
2.89	32%				57%	65%	
2.66	30%				53%	60%	
2.44	27%				48%	55%	
2.22	25%				44%	50%	
2.00	22%				39%	45%	
1.78	20%				35%	40%	
1.55	17%				31%	35%	
1.33	15%				26%	30%	
1.11	12%				22%	25%	
0.89	10%				18%	20%	
0.67	7%				13%	15%	
0.44	5%				9%	10%	
0.22	2%				4%	5%	
0	0%				0%	0%	


Long Intervals
Active Long Intervals (ALI)
• Extensive
• Normal
• Intensive
Passive Long Intervals (PLI)
• Extensive
• Normal
• Intensive
Short Intervals
Active Short Intervals (ASI)
• Extensive
• Normal
• Intensive
Passive Short Intervals (PSI)
• Extensive
• Normal
• Intensive
Tempo
• Time based
• Distance based
Sprint Interval Training (SIT)
Extensive
Intensive
Repeat Sprint Training (RST)
Intermittent Recovery

Velocity	%MSS	%ASR	Tlim	Dist	%VIFT	%MAS		REC	ALI	PLI	ASI	PSI	Tempo	SIT	RST
9.00	100%	100%	0 sec	0 m	177%	203%	MSS								
8.77	97%	95%	4 sec	35 m	173%	198%									95%
8.54	95%	90%	8 sec	69 m	168%	192%									90%
8.32	92%	85%	13 sec	104 m	164%	187%									
8.09	90%	80%	17 sec	139 m	159%	182%								80%	
7.86	87%	75%	22 sec	174 m	155%	177%								75%	
7.63	85%	70%	27 sec	209 m	150%	172%								70%	
7.40	82%	65%	33 sec	245 m	146%	167%								65%	
7.18	80%	60%	39 sec	282 m	141%	162%								60%	
6.95	77%	55%	46 sec	320 m	137%	156%							55%	55%	
6.72	75%	50%	53 sec	358 m	132%	151%							50%		
6.49	72%	45%	61 sec	399 m	128%	146%							45%		
6.26	70%	40%	70 sec	442 m	123%	141%							40%		
6.04	67%	35%	81 sec	487 m	119%	136%							35%		
5.81	65%	30%	93 sec	538 m	114%	131%						30%	30%		
5.58	62%	25%	107 sec	595 m	110%	126%						25%	25%		
5.35	59%	20%	124 sec	663 m	105%	121%					121%	20%	20%		
5.12	57%	15%	146 sec	748 m	101%	115%	VIFT				115%	15%			
4.90	54%	10%	177 sec	867 m	96%	110%				110%	110%	10%			
4.67	52%	5%	230 sec	1076 m	92%	105%				105%	105%	5%			
4.44	49%	0%	4-8min		88%	100%	MAS		100%	100%	100%	0%			
4.22	47%				83%	95%			95%	95%	95%				
4.00	44%				79%	90%			90%	90%	90%				
3.77	42%				74%	85%			85%						
3.55	39%				70%	80%			80%						
3.33	37%				66%	75%									
3.11	35%				61%	70%		70%							
2.89	32%				57%	65%		65%							
2.66	30%				53%	60%		60%							
2.44	27%				48%	55%		55%							
2.22	25%				44%	50%		50%							
2.00	22%				39%	45%									
1.78	20%				35%	40%									
1.55	17%				31%	35%									
1.33	15%				26%	30%									
1.11	12%				22%	25%									
0.89	10%				18%	20%									
0.67	7%				13%	15%									
0.44	5%				9%	10%									
0.22	2%				4%	5%									
0	0%				0%	0%		MAS	MAS	MAS	All	IFT/ASR	ASR	ASR	ASR

HIT Name		Work Interval				Rest Interval			Set information			
		Duration	MAS	IFT	ASR	Duration	MAS	IFT	W:R	Format	# of Sets	Rest btwn sets
Passive Long Intervals (PLI)												
Int	**1':2'**	60sec	100-110%	*85-95%*	*0-10%*	120sec	passive		1:2	10-15 x 1min	1-2sets	3-5min
	1'30':3'	90sec	100-110%	*85-95%*	*0-10%*	180sec	passive		1:2	8-12 x 90sec	1-2sets	3-5min
	2':4'	120sec	100-110%	*85-95%*	*0-10%*	240sec	passive		1:2	6-10 x 2min	1-2sets	4-6min
	3':6'	180sec	100-110%	*85-95%*	*0-10%*	360sec	passive		1:2	5-8 x 3min	1-2sets	5-7min
Norm	**1':1'**	60sec	95-105%	*80-90%*		60sec	passive		1:1	10-15 x 1min	1-2sets	3-5min
	1'30':1'30	90sec	95-105%	*80-90%*		90sec	passive		1:1	8-12 x 90sec	1-2sets	3-5min
	2':2'	120sec	95-105%	*80-90%*		120sec	passive		1:1	6-10 x 2min	1-2sets	4-6min
	3':3'	180sec	95-105%	*80-90%*		120sec	passive		1:1	5-8 x 3min	1-2sets	5-7min
Ext	**1':30''**	60sec	90-100%	*75-85%*		30sec	passive		2:1	10-15 x 1min	1-2sets	3-5min
	1'30:45''	90sec	90-100%	*75-85%*		45sec	passive		2:1	8-12 x 90sec	1-2sets	3-5min
	2':1'	120sec	90-100%	*75-85%*		60sec	passive		2:1	6-10 x 2min	1-2sets	4-6min
	3':1'30	180sec	90-100%	*75-85%*		90sec	passive		2:1	5-8 x 3min	1-2sets	5-7min
Active Long Intervals (ALI)												
Int	**1':2'**	60sec	90-100%	*75-85%*		120sec	60-70%	*50-60%*	1:2	10-15 x 1min	1-2sets	3-5min
	1'30':3'	90sec	90-100%	*75-85%*		180sec	60-70%	*50-60%*	1:2	8-12 x 90sec	1-2sets	3-5min
	2':4'	120sec	90-100%	*75-85%*		240sec	60-70%	*50-60%*	1:2	6-10 x 2min	1-2sets	4-6min
	3':6'	180sec	90-100%	*75-85%*		360sec	60-70%	*50-60%*	1:2	5-8 x 3min	1-2sets	5-7min
Norm	**1':1'**	60sec	85-95%	*70-80%*		60sec	55-65%	*45-55%*	1:1	10-15 x 1min	1-2sets	3-5min
	1'30':1'30	90sec	85-95%	*70-80%*		90sec	55-65%	*45-55%*	1:1	8-12 x 90sec	1-2sets	3-5min
	2':2'	120sec	85-95%	*70-80%*		120sec	55-65%	*45-55%*	1:1	6-10 x 2min	1-2sets	4-6min
	3':3'	180sec	85-95%	*70-80%*		120sec	55-65%	*45-55%*	1:1	5-8 x 3min	1-2sets	5-7min
Ext	**1':30''**	60sec	80-90%	*65-75%*		30sec	50-60%	*40-50%*	2:1	10-15 x 1min	1-2sets	3-5min
	1'30:45''	90sec	80-90%	*65-75%*		45sec	50-60%	*40-50%*	2:1	8-12 x 90sec	1-2sets	3-5min
	2':1'	120sec	80-90%	*65-75%*		60sec	50-60%	*40-50%*	2:1	6-10 x 2min	1-2sets	4-6min
	3':1'30	180sec	80-90%	*65-75%*		90sec	50-60%	*40-50%*	2:1	5-8 x 3min	1-2sets	5-7min
Passive Short Intervals (PSI)												
Int	**10:20**	10sec	*120-130%*	102.5-110%	20-30%	20sec	passive		1:2	4-8min	2-6sets	3-5min
	15:30	15sec	*120-130%*	102.5-110%	20-30%	30sec	passive		1:2	4-8min	2-6sets	3-5min
	20:40	20sec	*120-130%*	102.5-110%	20-30%	40sec	passive		1:2	4-8min	2-6sets	3-5min
	30:60	30sec	*120-130%*	102.5-110%	20-30%	60sec	passive		1:2	4-8min	2-6sets	3-5min
Norm	**10:10**	10sec	*110-120%*	95-102.5%	10-20%	10sec	passive		1:1	4-8min	2-6sets	3-5min
	15:15	15sec	*110-120%*	95-102.5%	10-20%	15sec	passive		1:1	4-8min	2-6sets	3-5min
	20:20	20sec	*110-120%*	95-102.5%	10-20%	20sec	passive		1:1	4-8min	2-6sets	3-5min
	30:30	30sec	*110-120%*	95-102.5%	10-20%	30sec	passive		1:1	4-8min	2-6sets	3-5min
Ext	**10:05**	10sec	100-110%	85-95%	0-10%	5sec	passive		2:1	4-8min	2-6sets	3-5min
	15:07	15sec	100-110%	85-95%	0-10%	7.5sec	passive		2:1	4-8min	2-6sets	3-5min
	20:10	20sec	100-110%	85-95%	0-10%	10sec	passive		2:1	4-8min	2-6sets	3-5min
	30:15	30sec	100-110%	85-95%	0-10%	15sec	passive		2:1	4-8min	2-6sets	3-5min
	30:10	30sec	90-100%	*75-85%*		10sec	passive		3:1	4-8min	2-6sets	3-5min
	45:15	45sec	90-100%	*75-85%*		15sec	passive		3:1	4-8min	2-6sets	3-5min
Active Short Intervals (ASI)												
Int	**10:20**	10sec	*110-120%*	95-102.5%	10-20%	20sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
	15:30	15sec	*110-120%*	95-102.5%	10-20%	30sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
	20:40	20sec	*110-120%*	95-102.5%	10-20%	40sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
	30:60	30sec	*110-120%*	95-102.5%	10-20%	60sec	60-70%	*50-60%*	1:2	4-8min	2-6sets	3-5min
Norm	**10:10**	10sec	100-110%	85-95%	0-10%	10sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
	15:15	15sec	100-110%	85-95%	0-10%	15sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
	20:20	20sec	100-110%	85-95%	0-10%	20sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
	30:30	30sec	100-110%	85-95%	0-10%	30sec	55-65%	*45-55%*	1:1	4-8min	2-6sets	3-5min
Ext	**10:05**	10sec	90-100%	*75-85%*		5sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	15:07	15sec	90-100%	*75-85%*		7.5sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	20:10	20sec	90-100%	*75-85%*		10sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	30:15	30sec	90-100%	*75-85%*		15sec	50-60%	*40-50%*	2:1	4-8min	2-6sets	3-5min
	30:10	30sec	80-90%	*65-75%*		10sec	45-55%	*35-45%*	3:1	4-8min	2-6sets	3-5min
	45:15	45sec	80-90%	*65-75%*		15sec	45-55%	*35-45%*	3:1	4-8min	2-6sets	3-5min
Tempo Strides												
Time	**10:30**	10sec	*135-145%*	115-125%	35-44%	30sec	passive		1:3	10-15min	2-5 sets	3-5min
	15:45	15sec	*130-140%*	110-120%	33-41%	45sec	passive		1:3	10-15min	2-5 sets	3-5min
	20:60	20sec	*130-140%*	105-115%	31-39%	60sec	passive		1:3	10-15min	2-5 sets	3-5min
	30:90	30sec	*125-135%*	102.5-110%	27-34%	90sec	passive		1:3	10-15min	2-5 sets	3-5min
	45:135	45sec	*120-130%*	100-105%	22-28%	135sec	passive		1:3	10-15min	2-5 sets	3-5min
	60:180	60sec	*115-125%*	95-102.5%	18-23%	180sec	passive		1:3	10-15min	2-5 sets	3-5min
Dist	**100m**	See Tempo Builder (Distance)					passive		1:3	10-15min	2-5 sets	3-5min
	200m						passive		1:3	10-15min	2-5 sets	3-5min
	300m						passive		1:3	10-15min	2-5 sets	3-5min
	400m						passive		1:3	10-15min	2-5 sets	3-5min
Sprint Interval Training (SIT)												
Int	**15sec**	15sec	all-out	all-out	77-82%	>2min	pass/act		1:6-8+	3-8 reps	1-3 sets	5-10 min
	20sec	20sec	all-out	all-out	72-77%	>2min	pass/act		1:6-8+	3-8 reps	1-3 sets	5-10 min
	30sec	30sec	all-out	all-out	63-68%	>3min	pass/act		1:6-8+	3-6 reps	1-3 sets	5-10 min
	45sec	45sec	all-out	all-out	51-56%	>4min	pass/act		1:6-8+	3-6 reps	1-3 sets	5-10 min
Ext	**15sec**	15sec	sub-max	sub-max	54-66%	<2min	pass/act		1:4-6-	5-12 reps	1-4 sets	4-6min
	20sec	20sec	sub-max	sub-max	50-62%	<2min	pass/act		1:4-6-	5-12 reps	1-4 sets	4-6min
	30sec	30sec	sub-max	sub-max	44-54%	<3min	pass/act		1:4-6-	5-10 reps	1-4 sets	5-7min
	45sec	45sec	sub-max	sub-max	36-45%	<4min	pass/act		1:4-6-	5-10 reps	1-4 sets	5-7min
Repeat Sprint Training (RST)												
	2sec	2sec	all-out	all-out	92-97%	<20sec	pass/act		1:10-	6-10 reps	2-4sets	5-10min
	4sec	4sec	all-out	all-out	90-95%	<20sec	pass/act		1:5-	6-10 reps	2-4sets	5-10min
	6sec	6sec	all-out	all-out	87-92%	<20sec	pass/act		1:4-	6-10 reps	2-5set	5-10min
	8sec	8sec	all-out	all-out	85-90%	<20sec	pass/act		1:3-	6-10 reps	2-4sets	5-10min
Intermittent Recovery (IR)												
	10sec	10sec	100-110%		0-10%	20sec	pass/act		1:2	10-15min	2-5 sets	3-5min
	15sec	15sec	95-105%			30sec	pass/act		1:2	10-15min	2-5 sets	3-5min
	20sec	20sec	90-100%			40sec	pass/act		1:2	10-15min	2-5 sets	3-5min
	30sec	30sec	85-95%			60sec	pass/act		1:2	10-15min	2-5 sets	3-5min

Shuttle Run Beep Test Collecting Sheet

#	Athlete Name	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
1		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
2		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
3		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
4		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
5		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
6		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
7		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
8		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
9		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
10		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
11		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
12		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
13		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
14		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
15		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
16		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
17		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
18		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
19		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
20		10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22

About

Mladen Jovanović is a Serbian Strength and Conditioning Coach and Sport Scientist. Mladen was involved in the physical preparation of professional, amateur and recreational athletes of various ages in sports, such as basketball, soccer, volleyball, martial arts, tennis and Australian rules football. In 2010, Mladen started the Complementary Training website and in 2017, developed the scheduling and monitoring application, AthleteSR. He is currently pursuing his PhD at the Faculty of Sports and Physical Education in Belgrade, Serbia.

Twitter: @physical_prep

Facebook: www.facebook.com/complementarytraining/

Website: www.complementarytraining.net

Glossary

AI - Artificial Intelligence

AnT – Anaerobic Threshold

ASR - Anaerobic Speed Reserve

AT – Aerobic Threshold

BW - Bodyweight

COD - Change Of Direction

CV - Critical Velocity (usually at the halfway between vGET/vLT/vLT2 and MAS, or around 90% MAS)

GET - Gas Exchange Threshold

GXT - Graded Exercise Test

HR – Heart Rate

HRmax - maximum heart rate

IFT - Intermittent Fitness Test

Leger-Bucher – Straight-line version of the beep test

LT - Lactate Threshold

LTHR – Lactate Threshold Hear Rate

MAS - Maximum Aerobic Speed

MSS - Maximum Sprinting Speed

MVP - Minimum Viable Product

RSA - Repeat Sprint Ability

RSS - Repeat Sprint Sequence

RST - Repeat Sprint Training

RTP - Return to Play

SIT - Sprint Interval Training

SJW - social justice warrior

SRBT - Shuttle Run Beep Test

SSG - Small Sided Games

T@MAS - time spent at MAS running velocity

T@VO_2peak - time spend at VO_2peak

UMTT – Straight-line version of the beep test

VamEval – Straight-line version of the beep test

vGET - velocity at GET (usually around 80% of MAS and 90% HRmax)

vLT - velocity at Lactate Threshold (usually around 80% of MAS and 90% HRmax)

VO_2peak - Maximal oxygen uptake one achieves in GXT

vVT1 - velocity at first ventilatory threshold

vVT2 - velocity at second ventilatory threshold

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