MONITORING IN SPORTS

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STRUCTURE

Theory

Introduce the foundational concepts of sports monitoring and familiarize with affordable digital tools.

Practice

Provide hands-on experience with gathering, recording and analysing sports data.

SPORTS MONITORING

REFERS TO THE SYSTEMATIC PROCESS OF COLLECTING, ANALYZING, AND INTERPRETING DATA RELATED TO ATHLETES' TRAINING, RECOVERY, WELL-BEING, PERFORMANCE, RISKS OF INJURY AND UNDER/OVERTRAINING

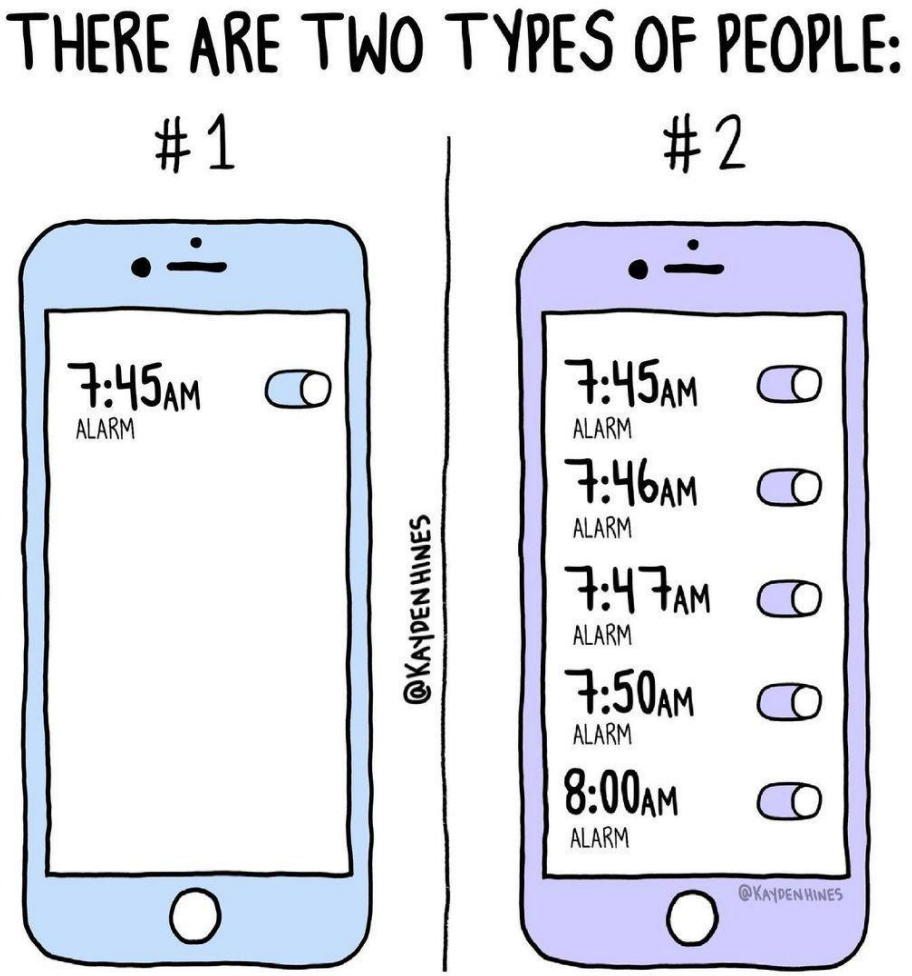
WHY MONITOR?

WHY MONITOR?

GIVES CREDIBILITY TO YOUR PROGRAM

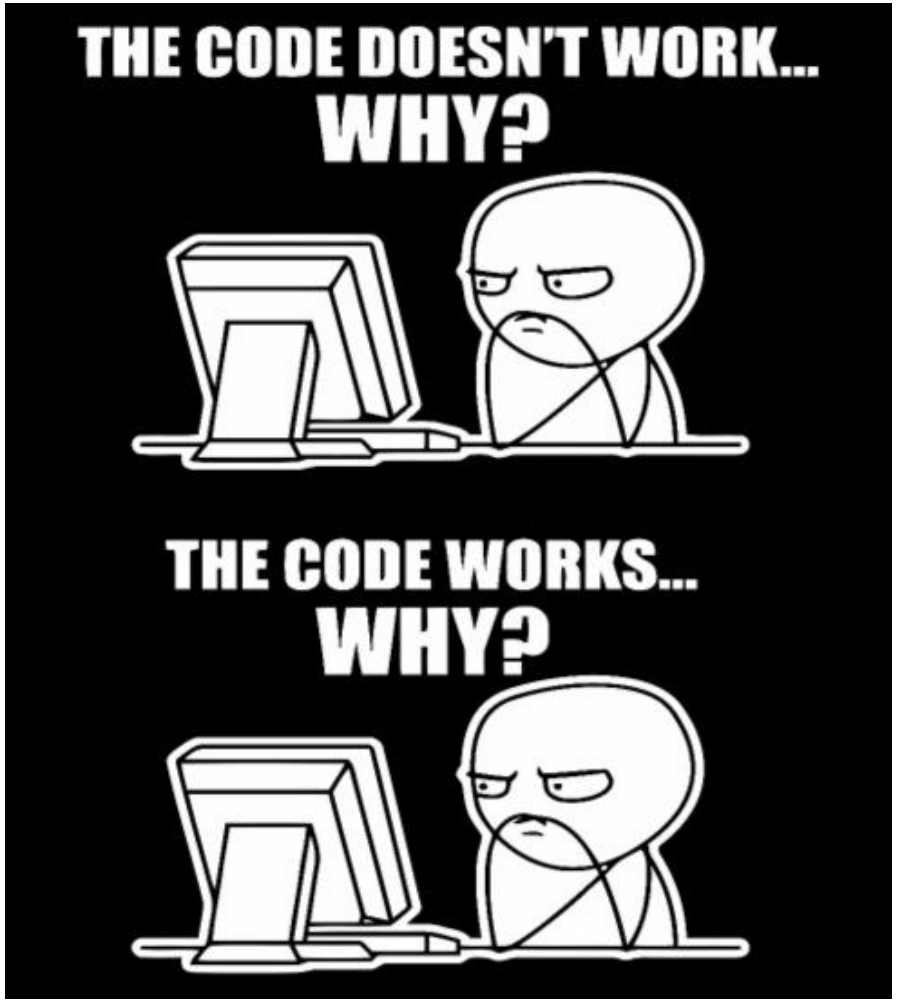
WHY MONITOR?

NOT ALL THE ATHLETES RESPOND THE SAME WAY



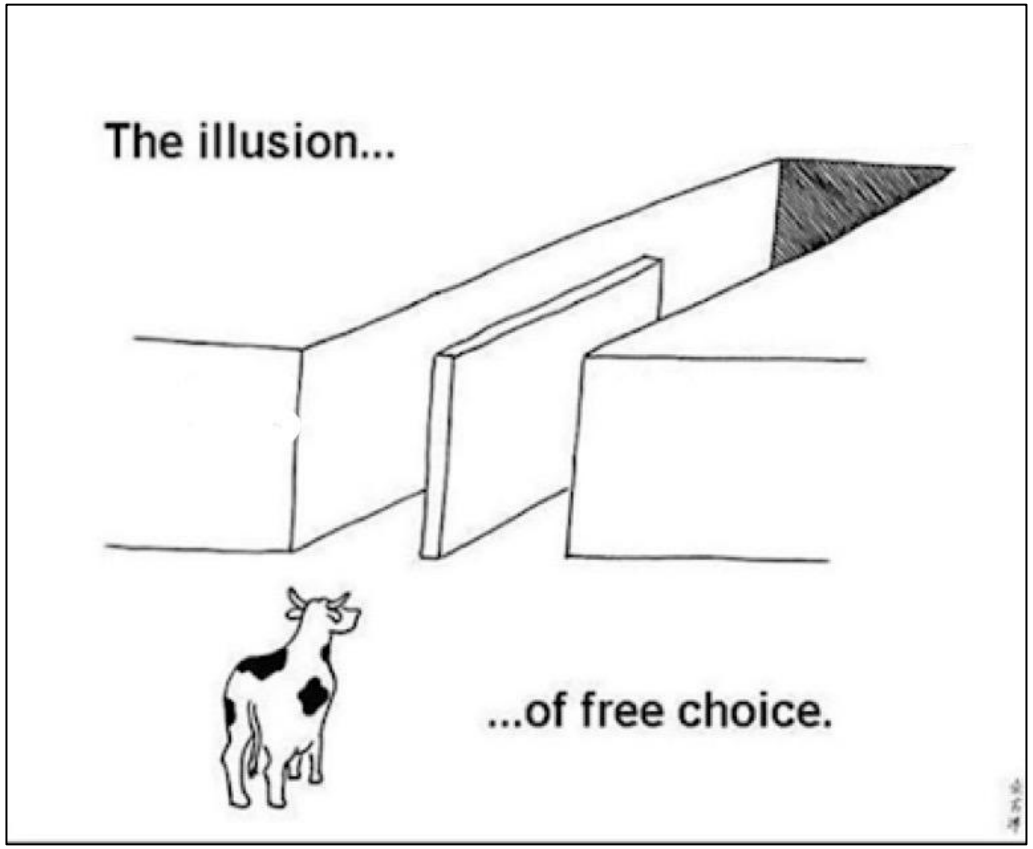
WHY MONITOR?

DETERMINES WHAT WORKS AND WHAT DOESN'T WORK



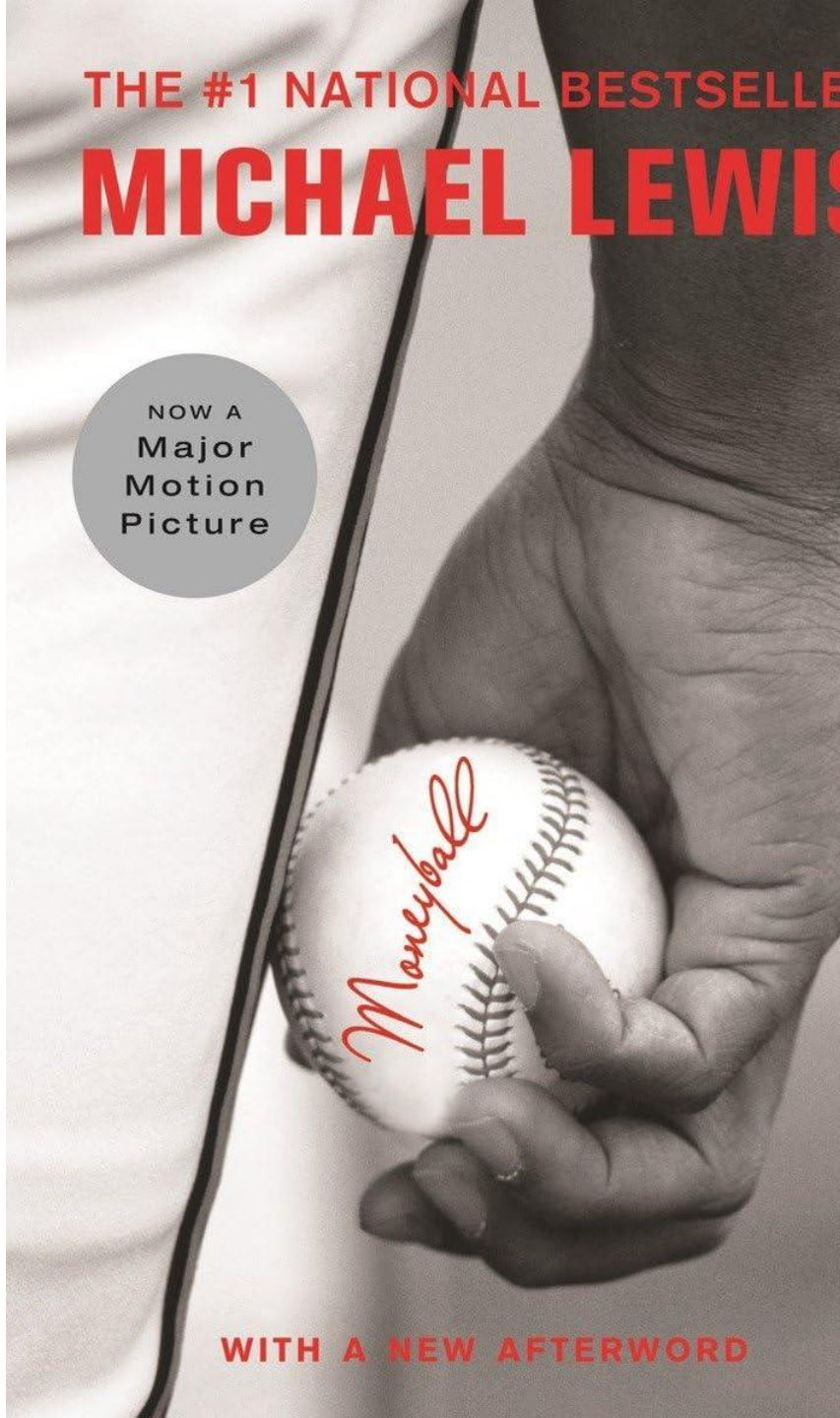
WHY MONITOR?

HELPS TO MAKE INFORMED DECISIONS ON PROGRAM ADJUSTMENTS



“PEOPLE OPERATE WITH BELIEFS AND BIASES. TO THE EXTENT YOU CAN ELIMINATE BOTH AND REPLACE THEM WITH DATA, YOU GAIN A CLEAR ADVANTAGE.”

Michael Lewis, Moneyball: The Art of Winning an Unfair Game



MONITORING HAS TWO MAIN GOALS:

DETERMINE WHEN THE ATHLETE IS UNABLE TO TOLERATE LOAD

DETERMINE WHEN THE ATHLETE IS ABLE TO TOLERATE LOAD

VARIOUS STREAMS OF DATA

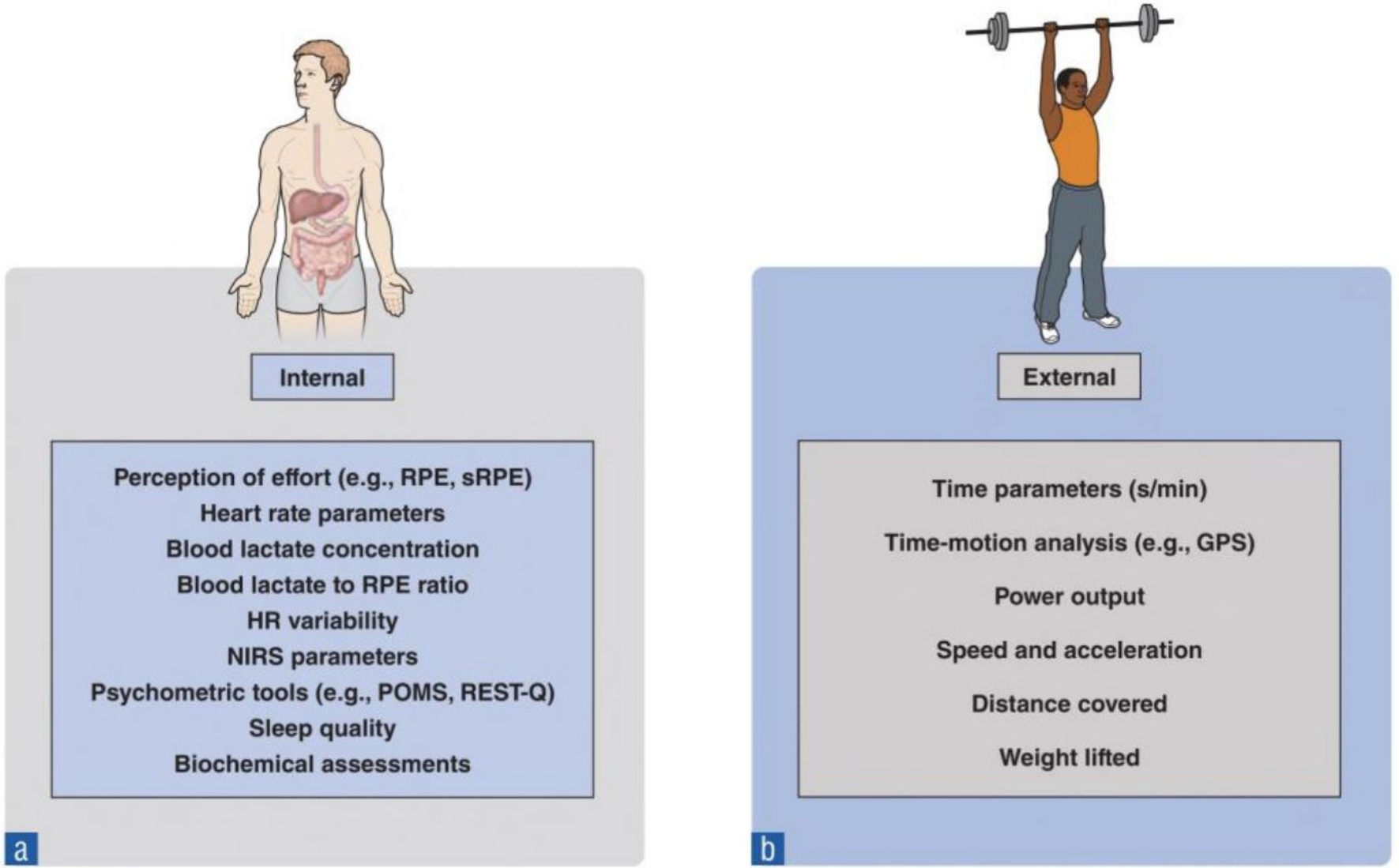


FIGURE 5.5 List of typical physiological key performance indicators (KPIs) used to assess *(a)* internal and *(b)* external training load.

McGuigan, 2017

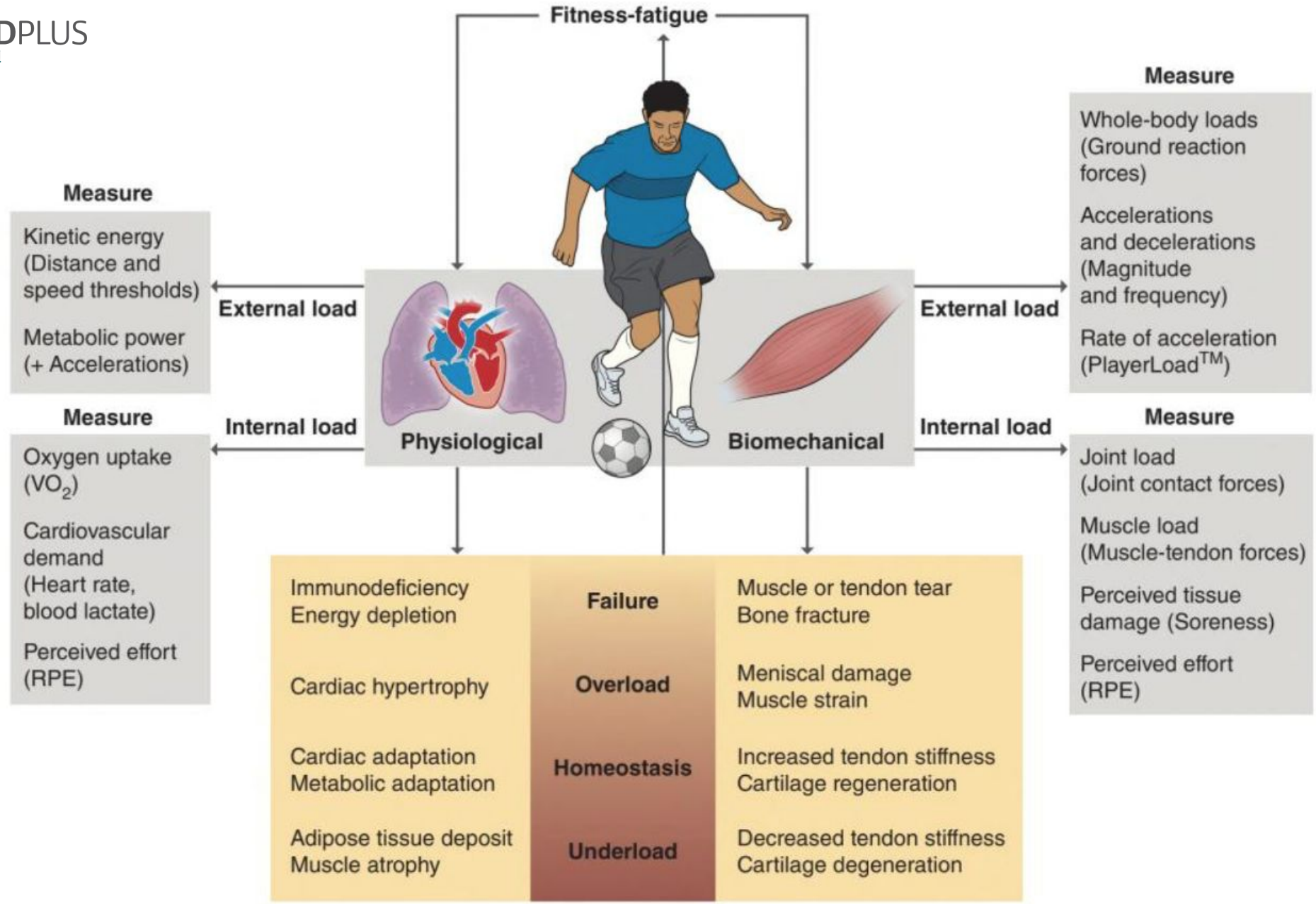


FIGURE 2.5 Monitoring physiological and biomechanical load.

Reprinted by permission from J. Vanrenterghem et al. (2017, pg. 2135-2142).

McGuigan, 2017

WHAT DATA SHOULD WE COLLECT?

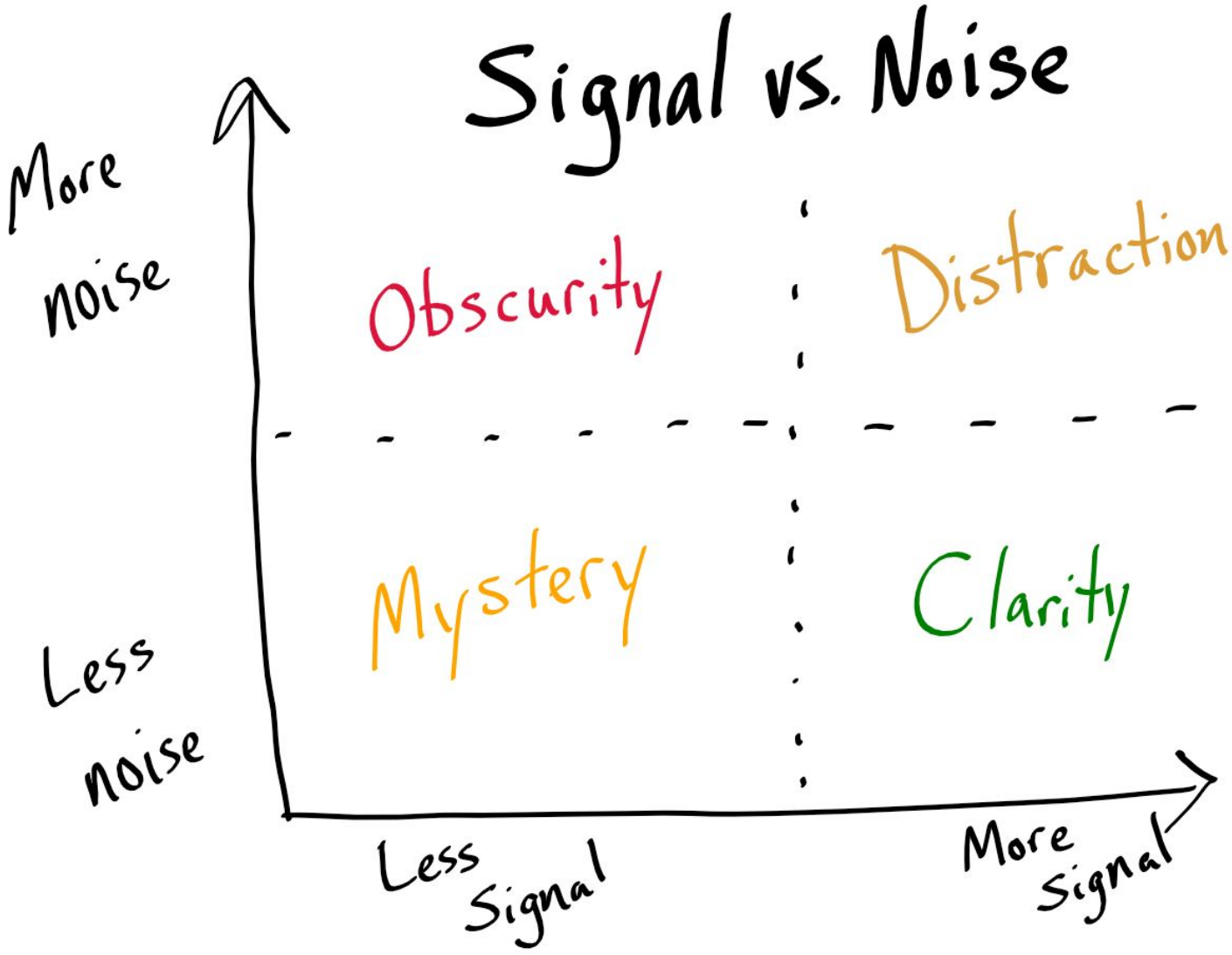
1. WHAT MAKES SENSE IN YOUR ENVIRONMENT
2. EASE OF DATA COLLECTION AND ANALYSIS
3. USABILITY OF THE DATA
4. SIGNAL OR NOISE
5. TIME & COST

TABLE 6.1 Common Athlete Monitoring Practices

Monitoring variable	Level of use	Level of evidence	Practical value
GPS and accelerometry	High	Moderate	Moderate to high
RPE	High	High	High
Wellness questionnaires	High	High	High
Biochemical and hormonal markers	Low	Moderate	Low
Heart rate measures	High	Moderate to high	Moderate to high
Performance tests	Moderate	Moderate	Moderate
Movement screening	High	Low	Moderate
Neuromuscular assessments (e.g., jumps)	Moderate	Moderate	Moderate

Based on published reports from Akenhead and Nassis (3), McCall et al. (94), Saw et al. (127), and Taylor et al. (141).

McGuigan, 2017



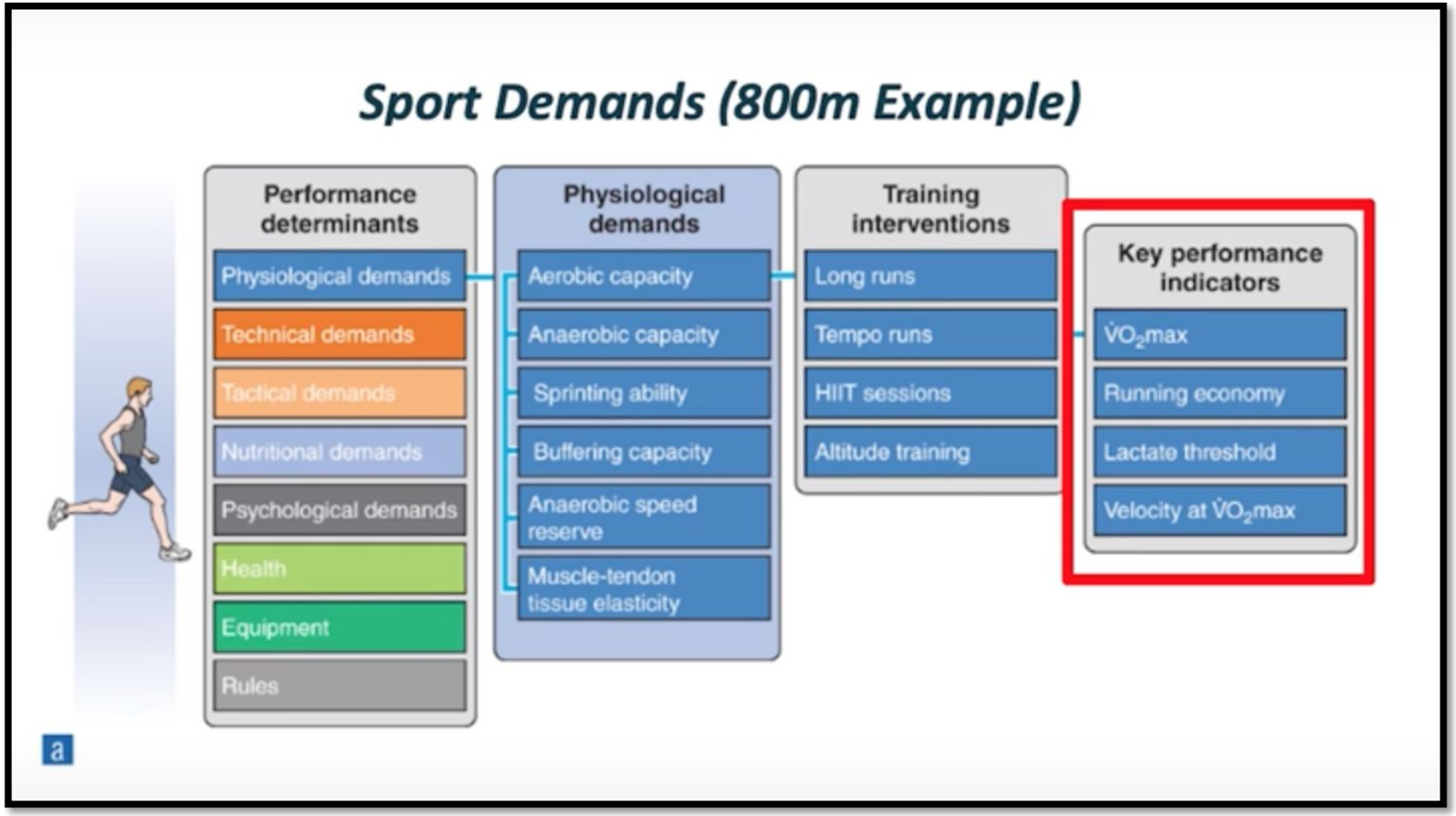
"FOCUS ON **SIGNAL** OVER NOISE. DON'T WASTE TIME ON STUFF THAT DOESN'T ACTUALLY MAKE THINGS **BETTER**." – ELON MUSK

TEXAS SHARPSHOOTER FALLACY

It occurs when a person selectively focuses on patterns after they emerge and creates a narrative to fit them, rather than objectively analyzing all the data.

KEY PERFORMANCE INDICATORS (KPI)

MEASURABLE VALUES USED TO ASSESS AN ATHLETE'S OR TEAM'S PERFORMANCE IN RELATION TO SPECIFIC GOALS

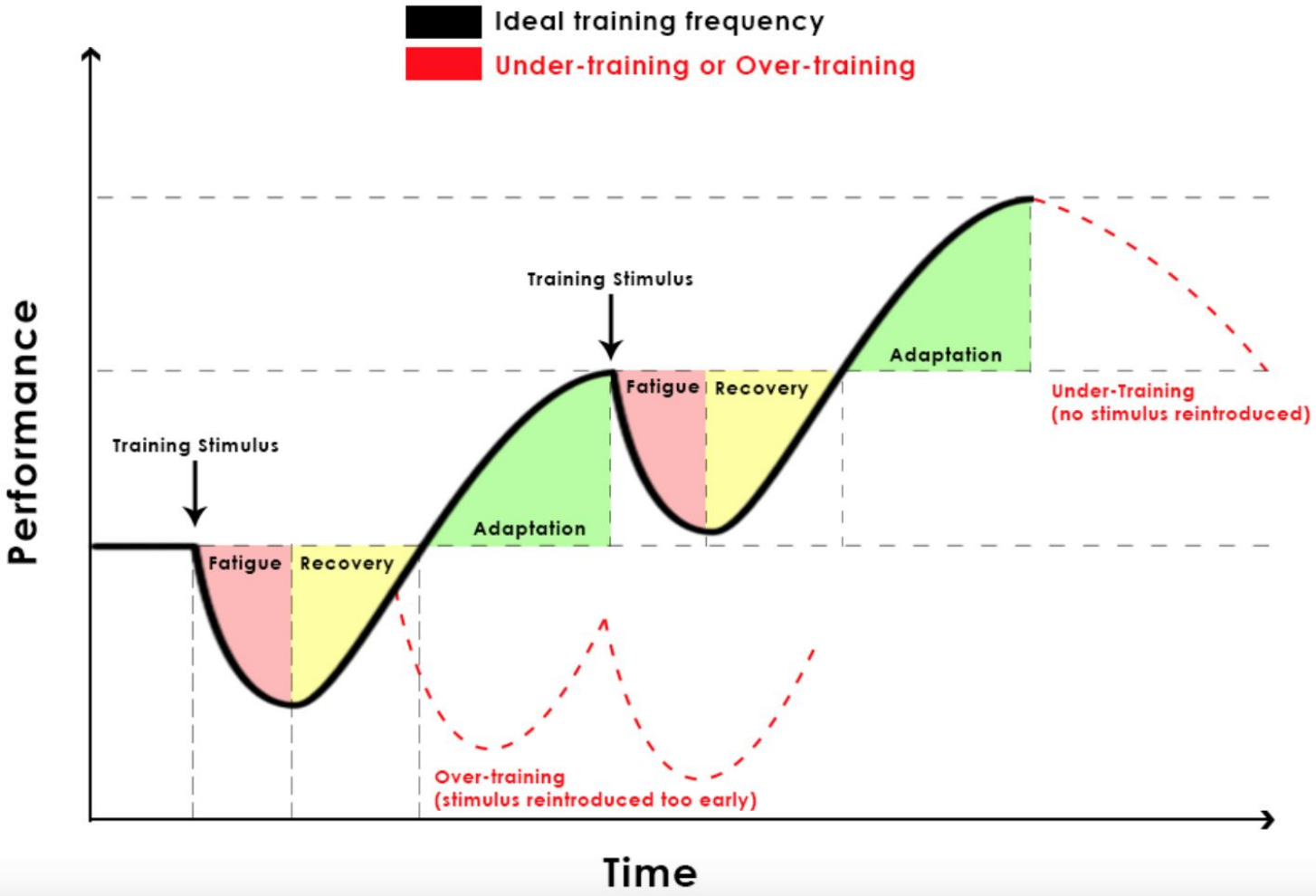


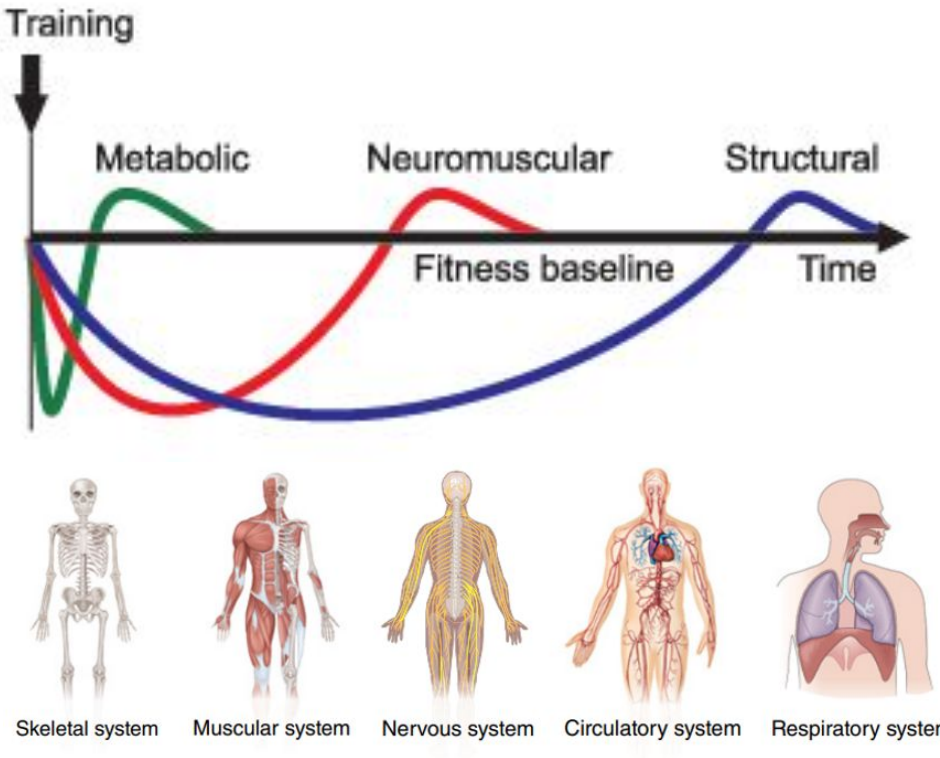
French & Torres Ronda, 2022

TESTING, MONITORING OR MONITOR USING TESTS

- WE CANNOT GO BACK IN TIME IF AFTER TESTING WE SEE THAT THE PROGRAM DIDN'T WORK
- EXPECTATION WHAT WILL HAPPEN
- DAY TO DAY VARIATIONS
- ATHELETES BUY-IN
- ADJUSTMENT

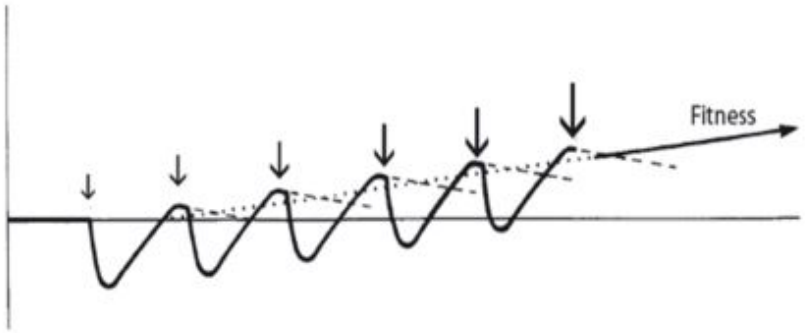
STRESS RECOVERY ADAPTATION

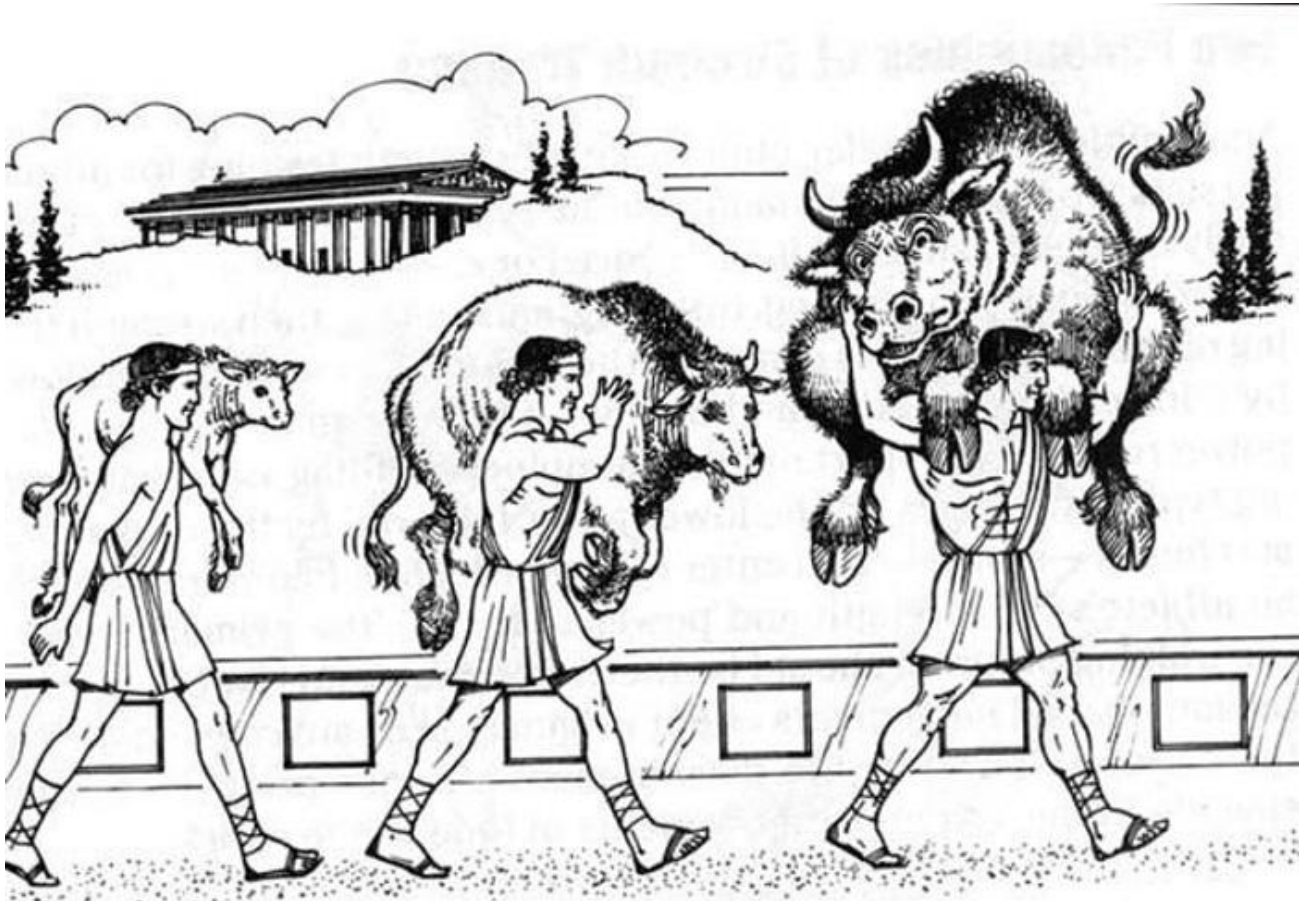




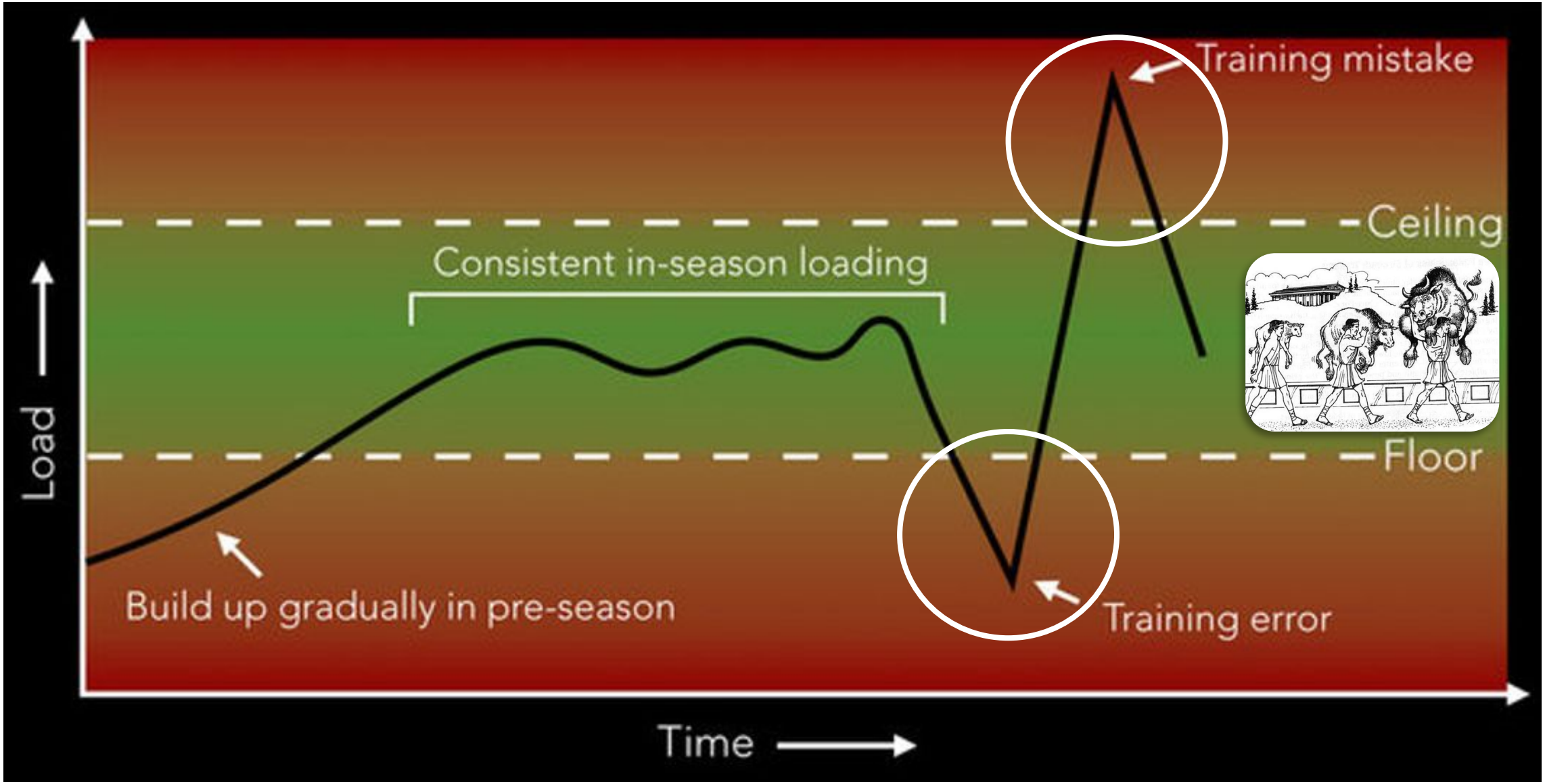
PROGRESSIVE OVERLOAD

MILO DIDN'T START WITH A BULL, HE STARTED WITH THE NEW-BORN CALF



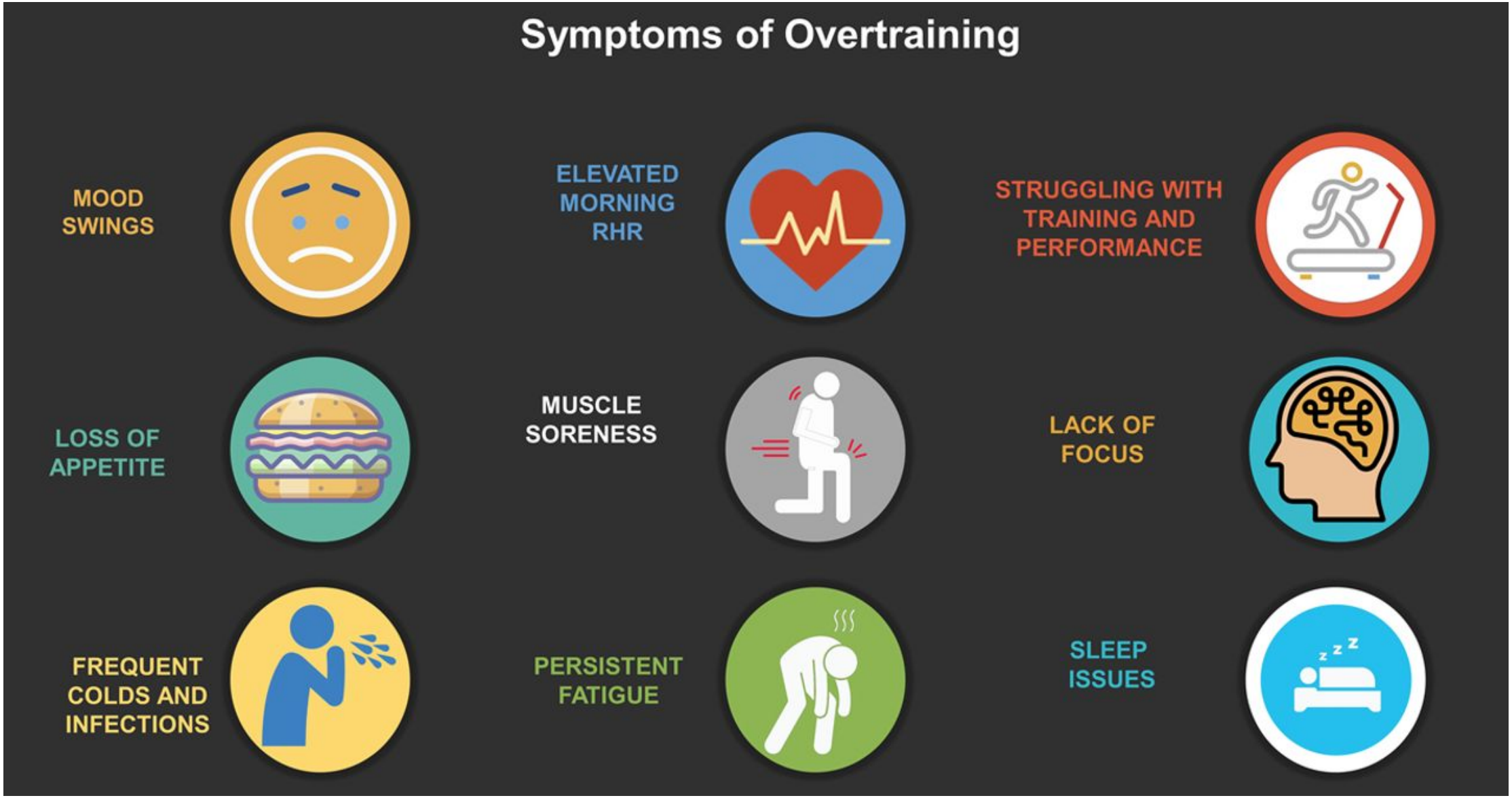


GAINS HAPPEN FROM RECOVERY BUT ONLY IF YOU KNOW YOUR MAX & MIN EFFECTIVE DOSE



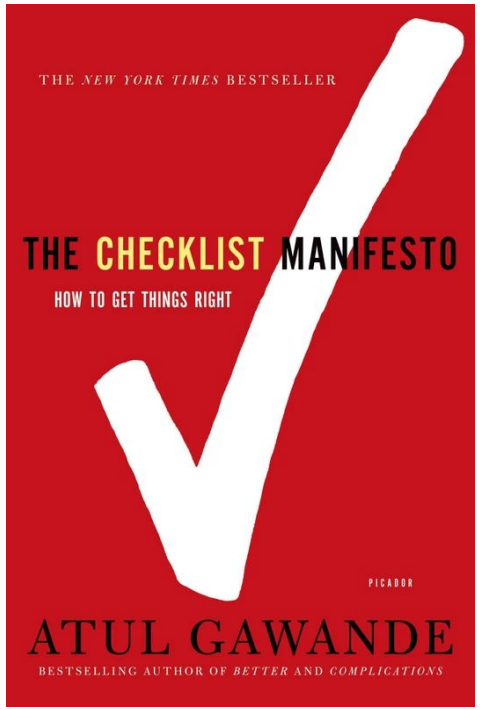
Fatigue	Increasing state of fatigue			
Training	Continual intensified training with inappropriate recovery			
Symptoms	Increasing severity of symptoms			
Outcome	**Acute fatigue**	**Overreaching**		**Overtraining**
		Functional	**Nonfunctional**	
Recovery	Day(s)	Days → weeks	Weeks → months	Months → ?
Performance	Increase	Temporary decrease	Decrease or no change	Decrease

Figure adopted from Bompa & Buzzichelli, 2018; Meeusen et al., 2013


Symptoms of Overtraining
MOOD SWINGS
ELEVATED MORNING RHR
STRUGGLING WITH TRAINING AND PERFORMANCE
LOSS OF APPETITE
MUSCLE SORENESS
LACK OF FOCUS
FREQUENT COLDS AND INFECTIONS
PERSISTENT FATIGUE
SLEEP ISSUES


DATA
DECISION
ACTION

IF STANDARD PROCEDURES ARE GOOD ENOUGH FOR PILOTS WHO FLY AIRPLANES, THEN THEY'RE GOOD ENOUGH FOR ME TOO.



PROCEDURES

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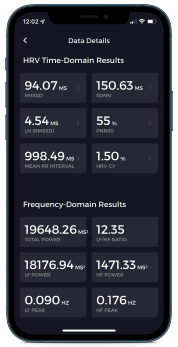
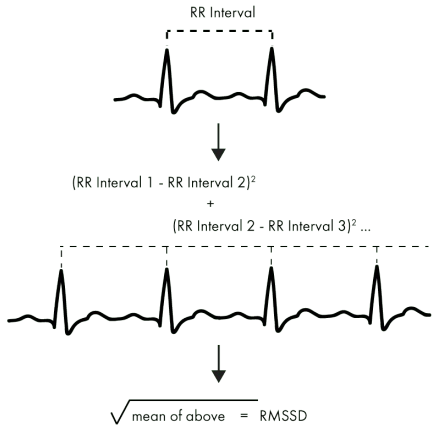


Elite HRV®

RMSSD



Google Forms

	5	4	3	2	1	Record Score
FATIGUE	Very fresh	Fresh	Normal	More tired than normal	Always tired	
SLEEP QUALITY	Very restful	Good	Difficulty falling asleep	Restless sleep	Insomnia	
GENERAL MUSCLE SORENESS	Feeling great	Feeling good	Normal	Increase in soreness/tightness	Very sore	
STRESS LEVELS	Very relaxed	Relaxed	Normal	Feeling stressed	Highly stressed	
MOOD	Very positive mood	A generally good mood	Less interested in others &/or activities than usual	Snappiness at team-mates, family and co-workers	Highly annoyed/ irritable/down	

myfitnesspal

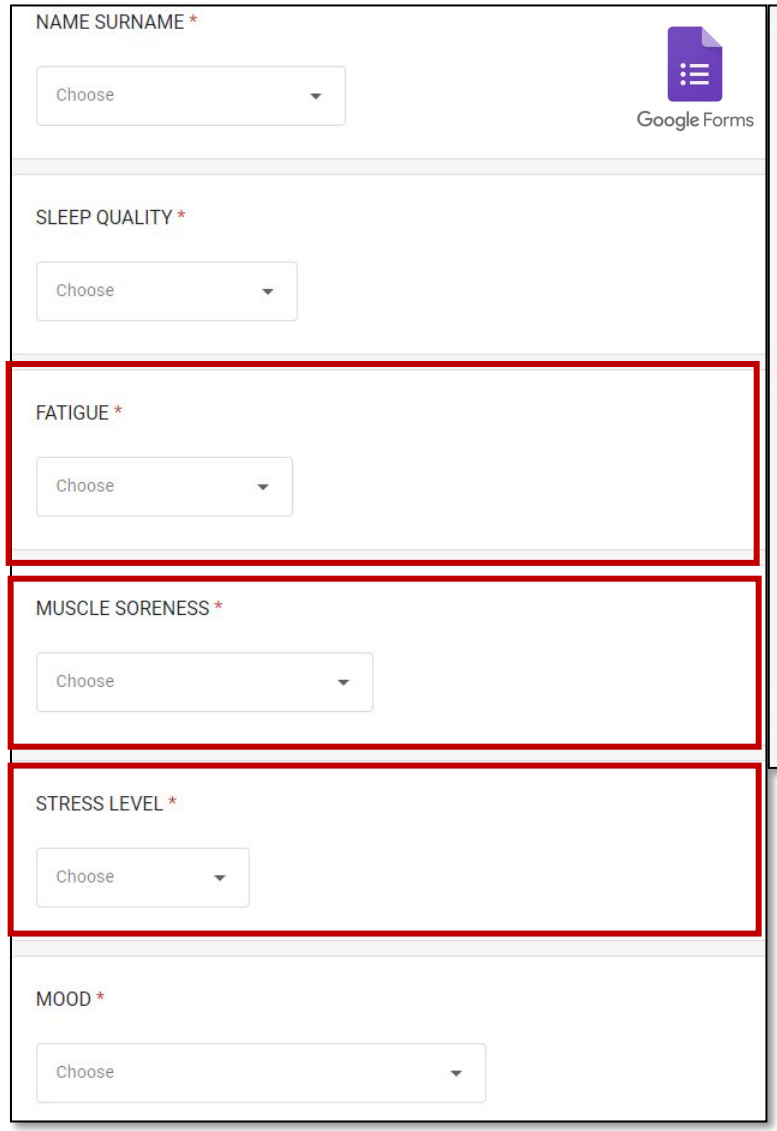
PM

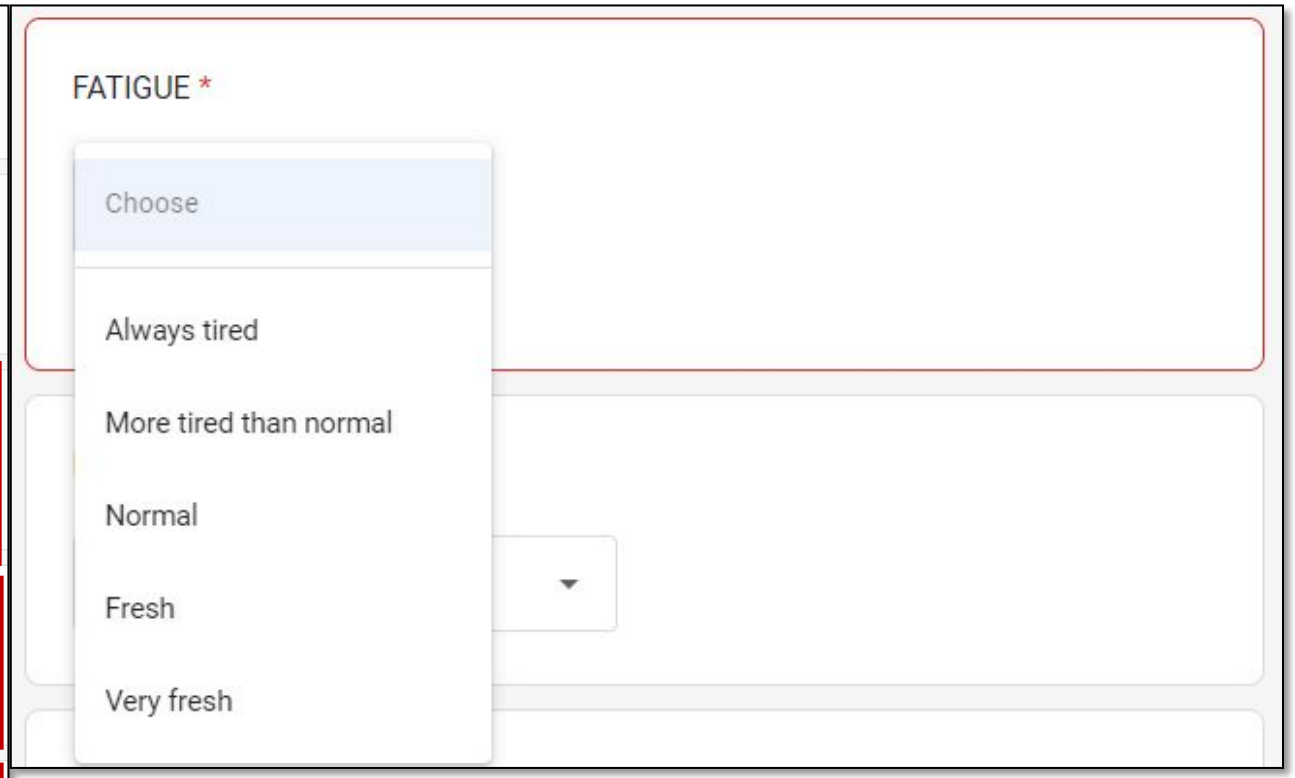
My Jump Lab

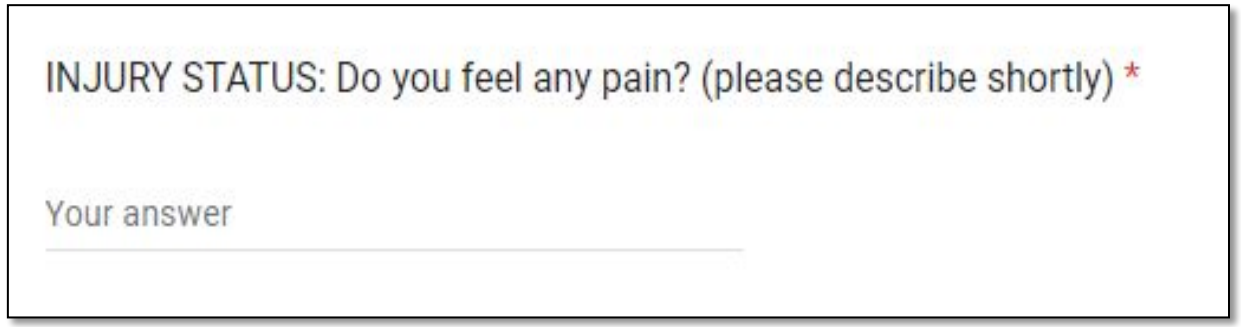
SFT

RPE SCALE	
1	Nothing
2	Very Easy
3	Easy
4	Comfortable
5	Somewhat Difficult
6	Difficult
7	Hard
8	Very Hard
9	Extremely Hard
10	Maximal/Exhaustion

WELLNESS QUESTIONNAIRE







WELLNESS QUESTIONNAIRE

FATIGUE	SLEEP QUALITY	MUSCLE SORENESS	STRESS LEVEL	MOOD	INJURY STATUS: Do you feel any pain?	READINESS TO TRAIN
More tired than normal	Good	Increase in soreness or tightness	Normal	Low interest in others or activities	Skauda keturgalvi nuo sumušimo.	IN
More tired than normal	Resteless sleep	Increase in soreness or tightness	Very relaxed	Very positive mood	no	IN
Very fresh	Good	Feeling great!	Relaxed	Very positive mood	No pain	IN
Fresh	Good	Normal	Relaxed	Good mood	No	IN
Fresh	Good	Feeling good	Normal	Good mood	No	IN
Fresh	Good	Feeling good	Relaxed	Good mood	No pain	IN
Fresh	Good	Increase in soreness or tightness	Relaxed	Good mood	.	IN
Very fresh	Very restful	Normal	Very relaxed	Very positive mood	No	IN
More tired than normal	Good	Increase in soreness or tightness	Normal	Good mood	Lower back pain	OUT

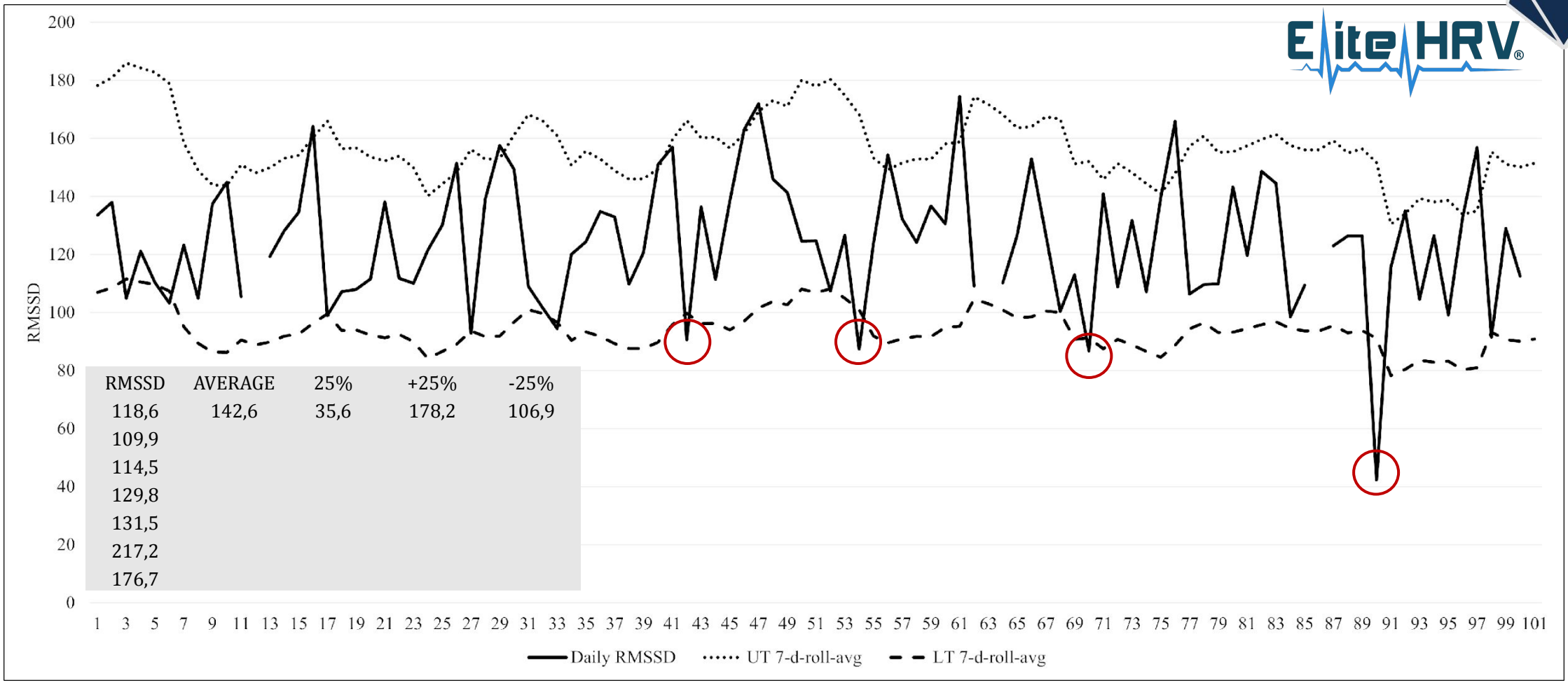
FATIGUE	SLEEP QUALITY	MUSCLE SORENESS	STRESS LEVEL	MOOD	SUM-SCORE
1	3	3	4	3	14
3	4	2	3	4	16
3	4	2	3	4	16
3	4	3	4	5	19
2	4	3	3	4	16
3	4	3	4	4	18
3	4	4	3	4	18
4	3	2	4	3	16

RECOMMENDATION TO CONSIDER

≤1.5 A RED FLAG

AVG	STDEV	Z-SCORE
17.0	0.5	-1.2

M-HEART RATE VARIABILITY



RMSSD	AVERAGE	25%	+25%	-25%
118,6	142,6	35,6	178,2	106,9
109,9				
114,5				
129,8				
131,5				
217,2				
176,7				

SUBMAX FITNESS TEST (SFT)

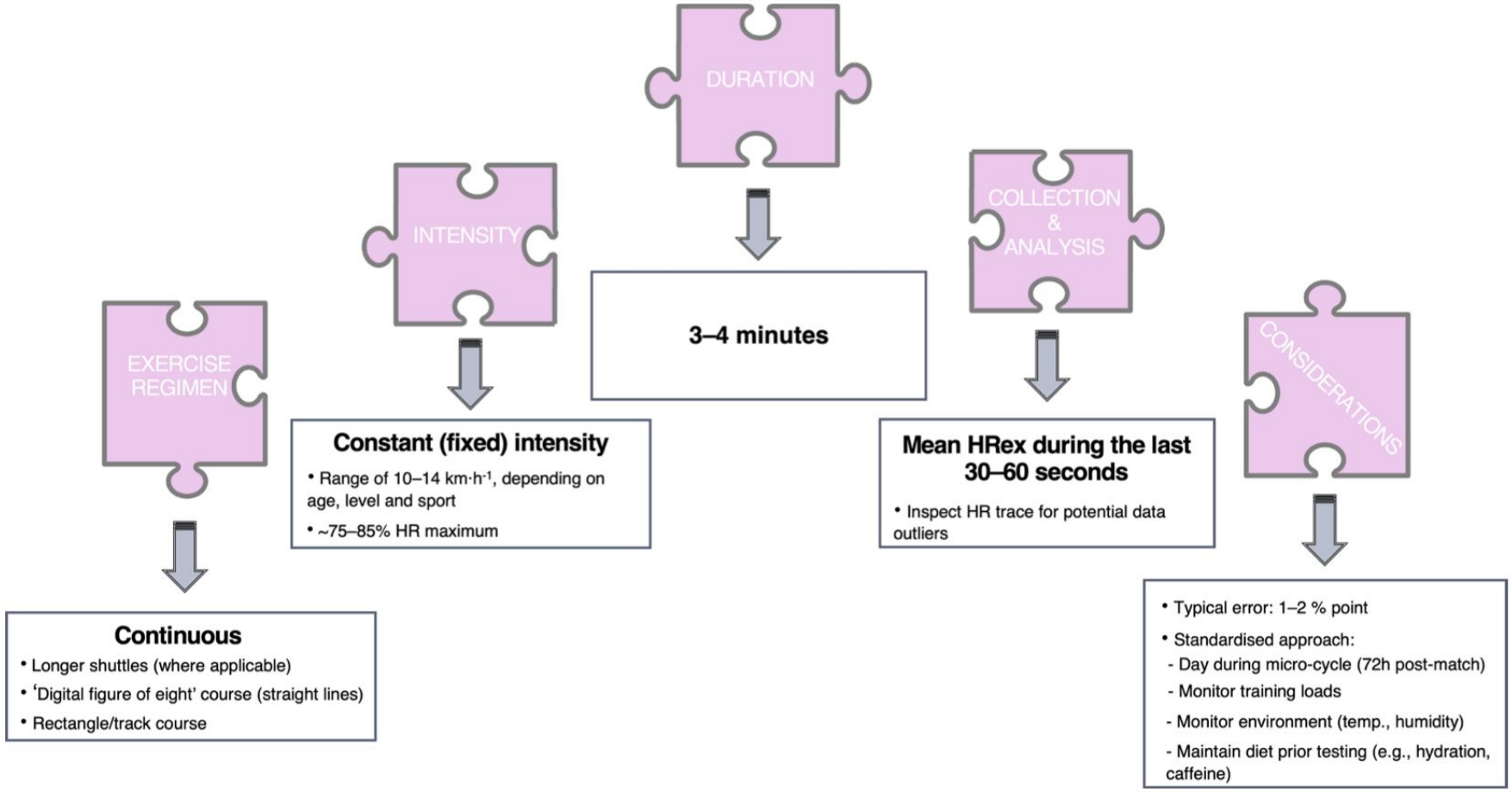


Fig. 8 Practical implications for designing and monitoring SMFT HRex in team sports. *temp.* temperature

RELATIVELY LOW 12 $km \cdot h^{-1}$ VELOCITY | LOW LEVELS OF FATIGUE | SHORT DURATION

Shushan, et al., 2023

SUBMAX FITNESS TEST (SFT)

- Distance: 100m
- Pace: 4min stable pace of 12 $km \cdot h^{-1}$
- Equipment: Pace is controlled by audio
- Measurement: End of 4min - passive recovery, HR registration

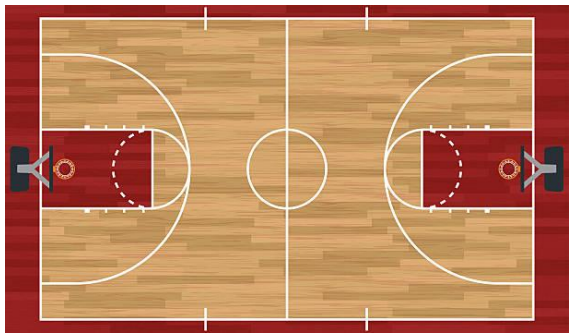
HR_{ex} - last 30sec HR average

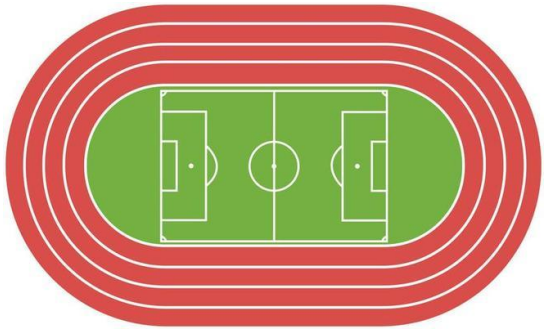
HR_{post1} – HR average during 60sec post

CHANGES IN TRAINING STATUS:

Weekly HR_{ex} change of 5bpm

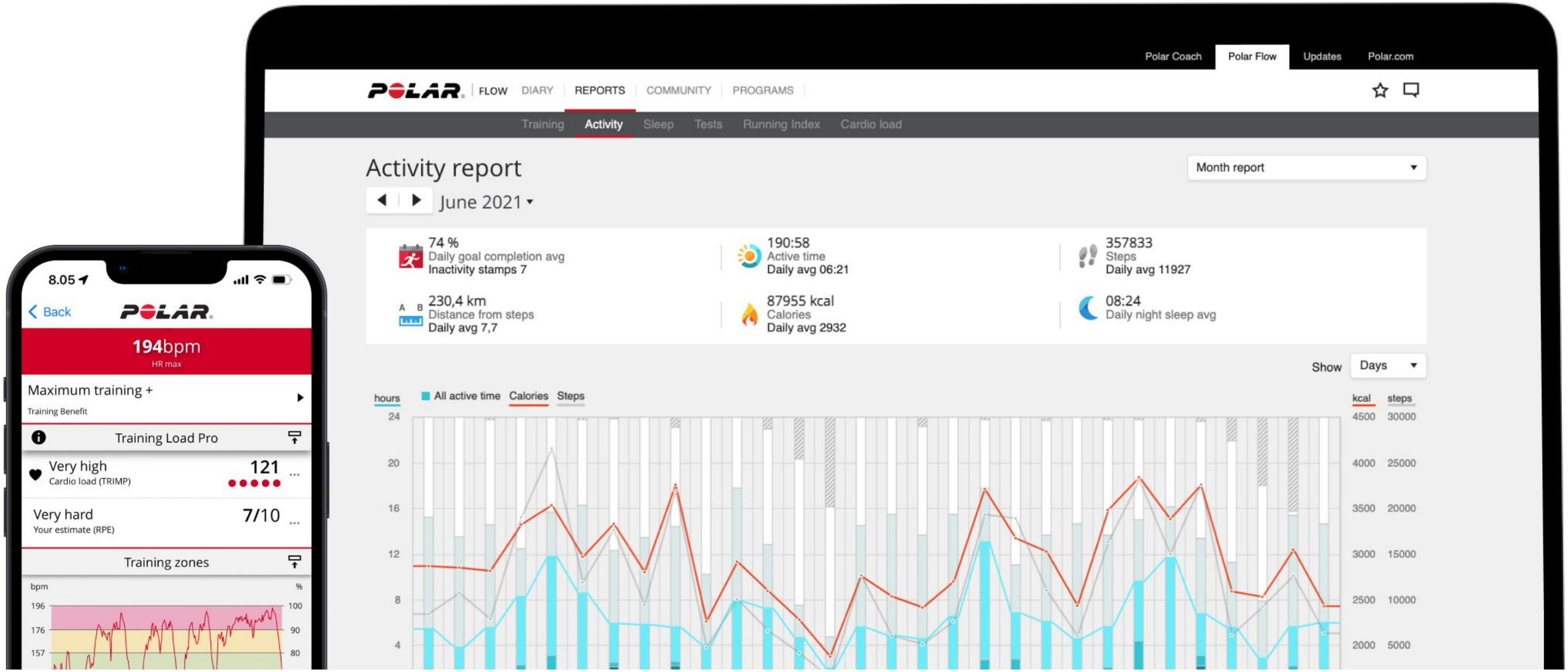
Weekly HR_{post1} change of 8bpm

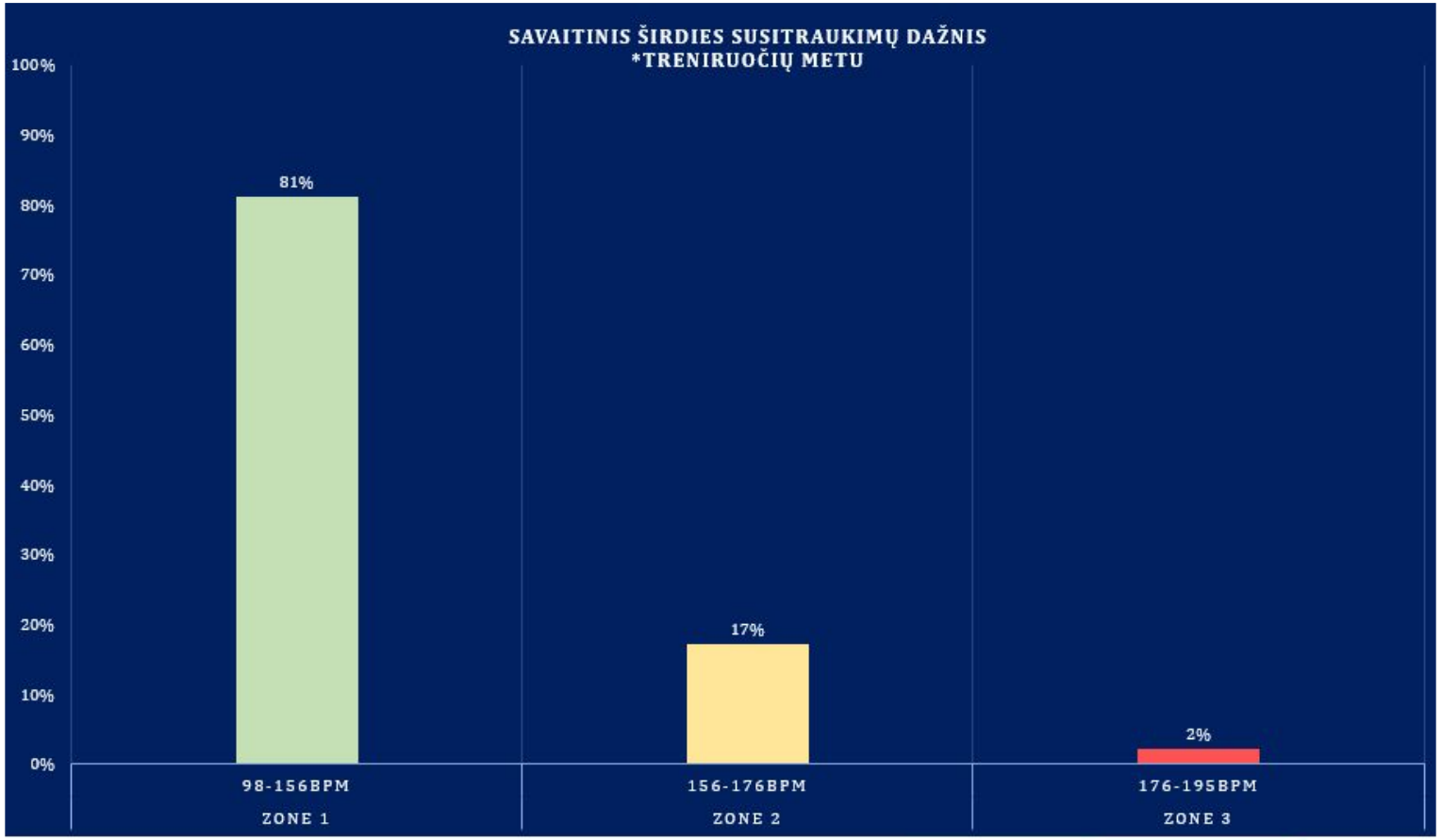




Rabbani, Kargarfard & Twist, 2018

HEART RATE MONITORING





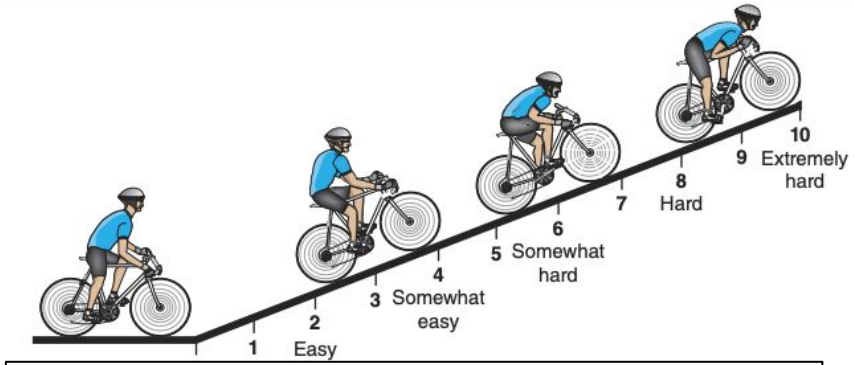
BE1	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	REAL TRAINING TIME
BEATS PER MINUTE TRESHOLDS	98-117bpm	117-137bpm	137-156bpm	156-176bpm	176-195bpm	
TIME SPENT IN DIFFERENT ZONES	0:47:33	1:30:17	0:55:05	0:41:10	0:05:12	3:59:17
% OF TIME SPENT IN DIFFERENT ZONES	20%	38%	23%	17%	2%	

FIRDAY MD-1						
Name	Heart Rate Band 1 avg.d.	Heart Rate Band 2 avg.d.	Heart Rate Band 3 avg.d.	Heart Rate Band 4 avg.d.	Heart Rate Band 5 avg.d.	Maximum Heart Rate
Warm up	0:02:39	0:06:25	0:00:29	0:00:03	0:00:00	143
Game & Reaction speed	0:02:06	0:02:52	0:01:22	0:00:00	0:00:00	159
1v0; 3v1	0:05:17	0:03:25	0:02:06	0:00:46	0:00:00	175
Groupal finishing	0:02:00	0:06:17	0:01:43	0:00:25	0:00:00	165
Reduced Match 8v7 35x40m	0:00:12	0:00:41	0:01:51	**0:07:04**	**0:02:27**	189
Total	0:12:16	0:19:42	0:07:33	0:08:20	0:02:37	199

SESSION RPE LOAD

DURATION OF THE SESSION (MIN) × S-RPE

RPE SCALE	
1	Nothing
2	Very Easy
3	Easy
4	Comfortable
5	Somewhat Difficult
6	Difficult
7	Hard
8	Very Hard
9	Extremely Hard
10	Maximal/Exhaustion



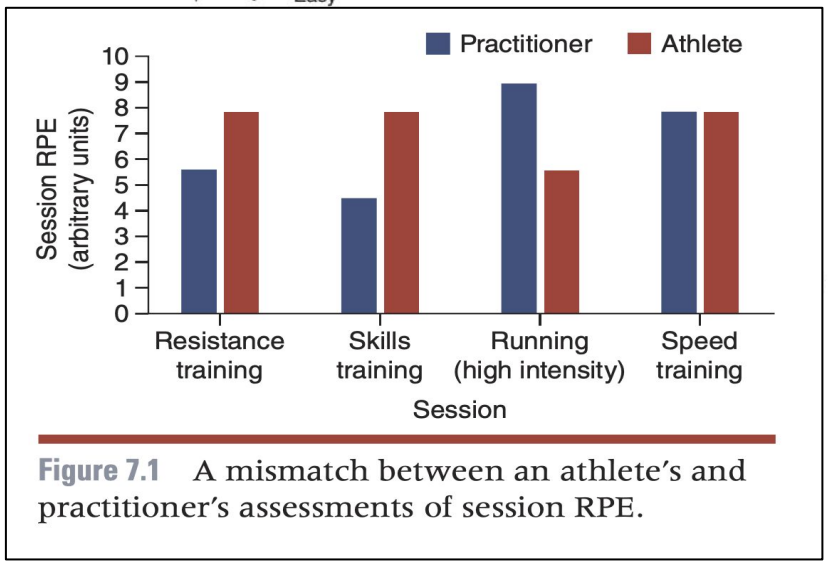
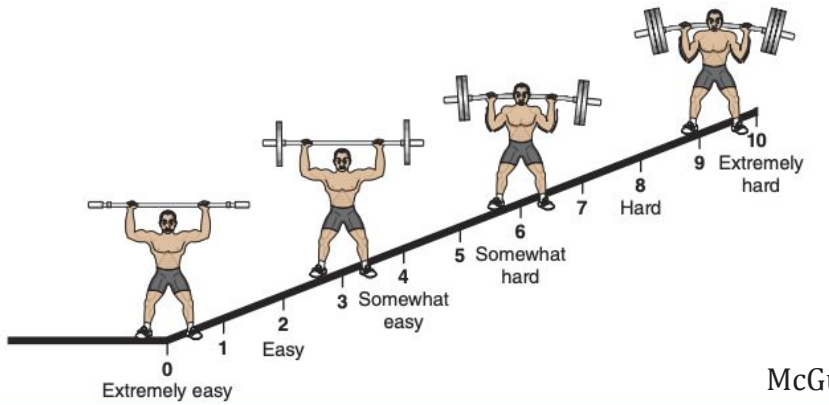


Figure 7.1 A mismatch between an athlete's and practitioner's assessments of session RPE.



McGuigan, 2017

Figure 4.2 Pictorial representations for the OMNI RPE scales for cycling, running, and resistance training.
Reprinted, by permission, from R.J. Robertson, 2004, *Perceived exertion for practitioners* (Champaign, IL: Human Kinetics), 11.

GYM LOAD

- Exercise A = (4 × 5 × 150 kg) = 3,000 kg
- Exercise B = (3 × 12 × 60 kg) = 1,440 kg
- Exercise B = (3 x 12 x 40 kg) = 960 kg
- **Total repetitions** = (20 + 24 + 24) = 68 repetitions
- **Training intensity** = (3,000 kg + 1,440 kg + 960 kg) ÷ 68 repetitions = 79 kg/repetition
- **Training load** = 79 kg/repetition x 5 RPE = 397AU
- **Training load** = session duration x RPE

LSU NORDPLUS Horizontal

CB	MID	ST	FB/WG
100.4	129.2	118.0	122.3
99.0	125.0	110.6	118.6
95.2	122.1	109.8	113.4
94.9	121.5	109.7	112.6
94.0	118.6	107.3	111.8
93.8	117.4	107.1	111.8
93.4	116.1	106.1	111.3
92.3	114.9	105.7	110.1

MD-5	MD-4	MD-3	MD-2	MD-1
401	471	541	376	335
451	593	506	535	317
403	583	617	458	340
413	528	763	448	357
419	658	572	351	348
374	471	647	328	293
445	542	624	420	388
421	351	660	456	419
503	604	517	343	331
367	521	652	504	368
392	638	595	478	406
389	674	559	521	427

TECHNOLOGY DOES NOT SOLVE PROBLEMS
PEOPLE SOLVE PROBLEMS

DATE	Name	Average Duration	Average Player Load	Average High Explosive actions	IMA High COD	IMA High Accel	IMA High Decel	Explosive/min
Tuesday, 12 January 2021	Rondo - (5v5+4) (3v3+1+3)	0:15:44	130	174	88	33	53	10.9
Wednesday, 13 January 2021	Rondo - 4+4v4 (6x2'+1')	0:17:57	126	159	73	37	49	8.8
Monday, 18 January 2021	Rondo - (4v4+4)	0:15:35	112	142	74	19	49	9.2
Tuesday, 26 January 2021	Rondo - (5v5+3) (4v4+4)	0:18:38	140	148	76	25	47	8.0
Monday, 1 February 2021	Rondo - (4v4+3) (4v4+4)	0:11:53	85	97	49	17	31	8.1
Tuesday, 2 February 2021	Rondo - (2+2+2v2)	0:09:50	49	100	51	8	41	10.0
Thursday, 4 February 2021	Rondo - (4v2+2) (8v4+4)	0:11:38	78	114	60	10	44	9.9
Friday, 5 February 2021	Rondo with transition - (3+3+3v3)	0:11:01	76	111	49	22	40	10.1
Monday, 8 February 2021	Rondo - 8x2	0:09:08	46	68	31	20	17	7.6
Monday, 8 February 2021	Rondo with Transition - 4x2 - 6x4	0:10:27	83	120	64	21	35	11.4
Tuesday, 9 February 2021	Rondo with transition - 1+4v4+1	0:06:13	55	70	32	12	26	11.7
Monday, 15 February 2021	Rondo - 3+3v3 (3x3'+30'')	0:10:39	92	78	42	19	17	7.4
Monday, 15 February 2021	Rondo - 6v6+5 (3x3'+30'')	0:09:17	83	47	29	7	11	4.9
Tuesday, 16 February 2021	Rondo 6v2 (6x30''+30'')	0:10:53	63	48	34	5	9	4.4

TRAINING TRAFFIC LIGHT SYSTEM

GO!

GO EASY

PERFORMANCE IS THE METRIC THAT MATTERS THE MOST

AND YET THERE IS A POSSIBILITY FOR US TO LOSE SIGHT OF IT IF WE ONLY FOCUS ON WELLNESS AND T-LOAD METRICS!

FEARS OF OVER-PROTECTION CULTURE:
"IT IS ROBBING CURRENT AND FUTURE GENERATIONS OF 'ROBUSTNESS"

- "Every time a sport scientist runs out on the court and stops someone from training or restricts minutes, it sends a message to the athlete and the coach that the sport scientist has no faith in their own ability to develop a program that creates robust and resilient athletes".
- "The sports science guy comes up and says 'I don't think you should train today, you're at that level, if you teeter over the edge you won't be fit for Saturday; have a rest day".
- 'All of a sudden you starting drilling someone in training, and a sports science bloke pops over: 'Woah, woah, woah, he's in the red".

Daily Mail Sports. (2016, May 11)

PUTTING THE PIECES TOGETHER

1. BE OBJECTIVE

2. CHOOSE ONLY WHAT MAKES SENSE FOR YOU

3. MAKE MONITORING PART OF THE TRAINING PROCESS

4. SET UP ANALYSIS APPROACHES THAT ANSWER IMPORTANT QUESTIONS

5. THERE IS NO POINT IN COLLECTING DATA IF YOU DON’T USE IT TO INFORM YOUR DECISIONS


OUR JOB IS TO
INSPIRE BELIEF
NOT CREATE
DOUBT