Training in the 'sweet spot' – the relationship of volume, physiological strain, and training effect

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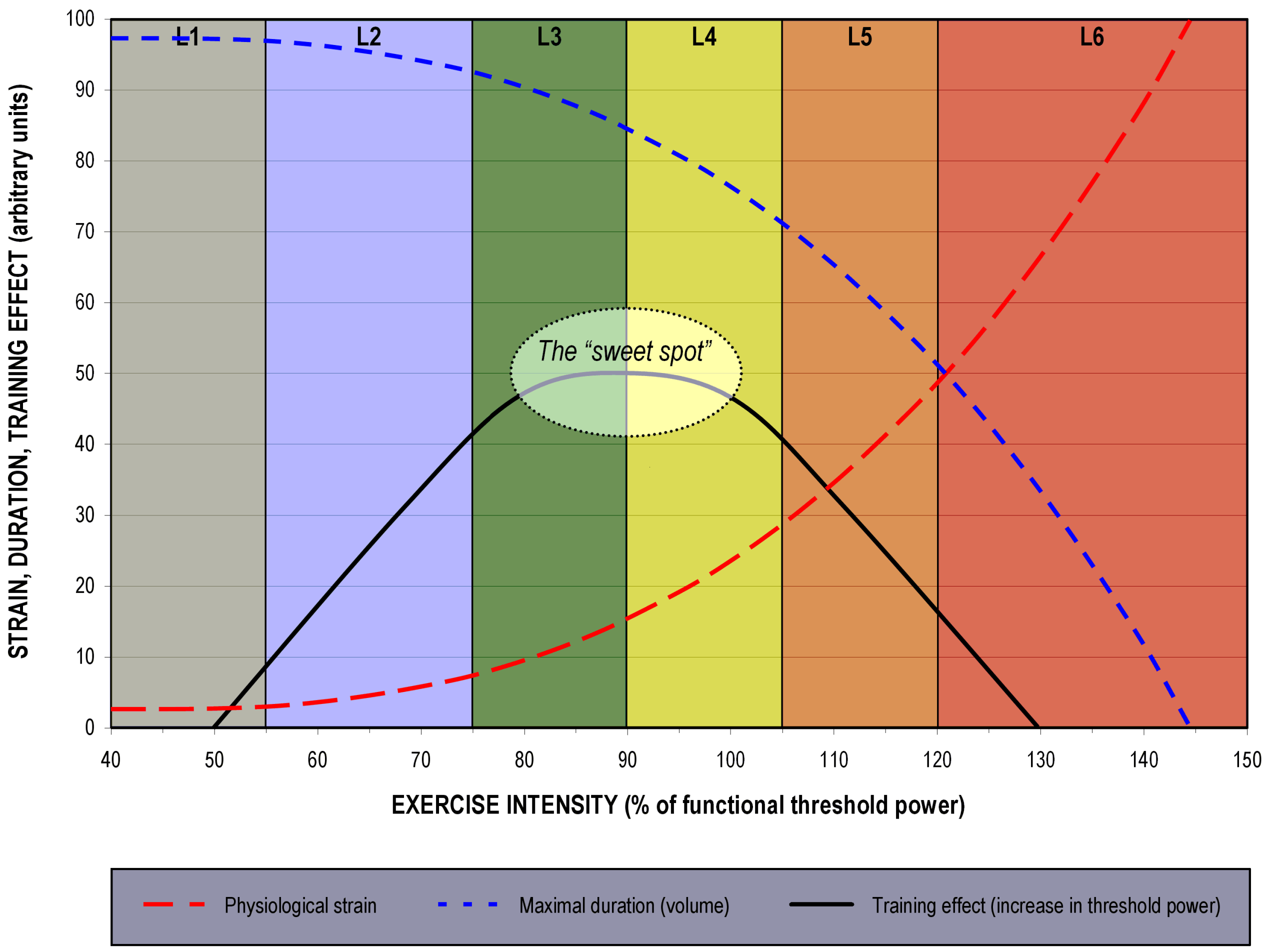

Training load optimization for increasing threshold power.

This figure depicts the relationships of physiological strain (i.e., response to training stress), maximum tolerable or achievable training duration/volume, and training effect in terms of the increase in muscular metabolic fitness/functional threshold power* (FTP), as a function of training intensity expressed relative to FTP.

Obviously, as exercise intensity increases, so too does physiological strain, in a quasi-exponential fashion, whereas the maximum duration/total volume of training that can be performed decreases in essentially a mirror-image manner. The increase in metabolic fitness, however, approximates an inverse-parabolic function: at very low intensities there is no overload, and hence no training adaptation, while at very high intensities, the adaptations induced are either qualitatively different (e.g., true sprint training), or, due to the ever-increasing physiological strain, you simply cannot do enough total volume to achieve the same degree of overload and resultant physiological adaptation (increase in FTP). In between these extremes you are, to a large degree, simply trading volume for intensity and vice-versa, with little impact on the overall magnitude of the training effect (the colored zones are simply meant to describe the general nature of these relationships for purposes of illustration, and should not be held to hard and fast, especially since an Excel spreadsheet was used instead of graphics program, imposing certain constraints). Even so, there tends to a "sweet spot," seemingly around the border between Levels 3/4, where the combination of intensity and volume is maximized while avoiding an excessive increase in physiological strain, and it is interesting to note that this is where many people like to train when they fall into the mode of banging out hard-ish rides day-after-day, yet this is precisely what is often considered the classic "no man's land" in terms of training intensity.

At least one coach, however, having had great success by training his athletes at "sub-Level 4," has suggested that the schema of training levels I have proposed be modified to include this additional level, or that Level 4 be split such that the lower part results in the largest increase in threshold power, with the upper part to be avoided until you need to squeeze out the last per cent of improvement. While I am not yet convinced of the need for such a change, I *do* believe that once you are above FTP, the increase in physiological strain/reduction in training that can be performed tends to outweigh any benefit from increasing the intensity, such that ~103-108% of FTP is something of a grey zone, and the relative efficacy of ~10 minute intervals seems questionable.

Two final cautions: the above figure shows the *absolute* effectiveness of Level 3/4, in that you get more of an effect since the stress is lower than Level 4, and you can go longer (plus you get the added benefit of more glycogen storage). In fact, you *must* go longer to get the added effect, so if you only have an hour to ride (or, say, if peaking just before an event such as a TT), a 2 x 20 interval workout would be a better choice since it gives you more "bang for the buck," i.e., is relatively more time-effective. Secondly, it is important to realize that stress, duration, and training effect are plotted as a function of % FTP, not normalized power. Although the two often get used interchangeably, when there is a large difference between them (i.e., when, power is highly variable), there will be less training effect.

*Functional threshold power is defined as average power for a 60 minute, flat time trial.

Thanks to Frank Overton for suggesting the term 'sweet spot.'

Magnitude of adaptations of by training level.

EXPECTED PHYSIOLOGICAL/ PERFORMANCE ADAPTATIONS	**TRAINING LEVEL**					
	2	**3**	**4**	**5**	**6**	**7**
Increased plasma volume	✓	✓✓	✓✓✓	✓✓✓✓	✓	
Increased muscle mitochondrial enzymes	✓✓	✓✓✓	✓✓✓✓	✓✓	✓	
Increased lactate threshold	✓✓	✓✓✓	✓✓✓✓	✓✓	✓	
Increased muscle glycogen storage	✓✓	✓✓✓✓	✓✓✓	✓✓	✓	
Hypertrophy of slow twitch muscle fibers	✓	✓✓	✓✓	✓✓✓	✓	
Increased muscle capillarization	✓	✓✓	✓✓	✓✓✓	✓	
Interconversion of fast twitch muscle fibers (type IIb → type IIa)	✓✓	✓✓✓	✓✓✓	✓✓	✓	
Increased stroke volume/maximal cardiac output	✓	✓✓	✓✓✓	✓✓✓✓	✓	
Increased VO_{2max}	✓	✓✓	✓✓✓	✓✓✓✓	✓	
Increased muscle high energy phosphate (ATP/PCr) stores					✓	✓✓
Increased anaerobic capacity ("lactate tolerance")				✓	✓✓✓	✓
Hypertrophy of fast twitch fibers					✓	✓✓
Increased neuromuscular power					✓	✓✓✓

Note: this table is meant to indicate the relative 'potency' of each training level, i.e., the extent to which training at a particular intensity *for a given period of time* is expected to induce the listed adaptations, however, there will always be a trade-off between training intensity and training volume, which is unaccounted for here. With respect to increasing resting glycogen stores, for instance, this means that a whole lot (whatever that is) of training at Level 2 might be just as, if not more effective than much less training at, say, Level 3.