LETTERS TO THE EDITOR

Letters to the Editor

To the Editor:

Arne Guellich and colleagues[1] have confirmed the effectiveness of "polarized training" for rowing performance as it was previously shown in other endurance sports.[2] Guellich and colleagues stated that "possible mechanisms underlying a potential association between intensity polarization and later success require further investigation," suggesting the absence of concluding evidence supporting the effectiveness of the polarized training. The key point is the "violation" of the specificity training principle. The paradox of this violation is that, despite the fact that competitive physiological demands are typically in those intensities close to or at VO_{2max} levels, the most appropriate training intensities for performance enhancement seem to be at low (eg, VT_1) and supramaximal intensities (eg, 115% VO_{2max}). Subsequently, it can be speculated about an "adaptive conflict" for those intensities between the VT_2 and VO_{2max}, suggesting that these intensities are critical for the organism or less profitable from a dose–response perspective. Similarly, we should reconsider a previous proposal of a "interference phenomenon" during concurrent strength and endurance training,[3] which reinforces the notion of polarization and which seems highly effective in our own practical experience.

From an evolutionary point of view, the survival of our Late Paleolithic ancestors depended on hunting and gathering.[4] Therefore, it is logical to establish a link between the physical demands of our ancestors and our gene regulation for our further understanding of the training adaptations of the human body. Given the polarized profile of *Homo sapiens* physical activities (walking, slow running, throwing, sprinting) in those ancient times, it might be suggested that our gene regulation could favor this polarized profile of trainability. From this perspective, the "homeostatic crisis" that develops during activities performed at intensities between VT_2 and VO_{2max} might well be an indicator of our genetic limitations for these metabolic demands. Further, it has been shown that the first ventilatory threshold might demarcate a "binary" threshold for autonomic nervous system recovery in highly trained runners.[5] This suggests a reduced tolerance to these workloads. Therefore, future studies should investigate the genetic expression of the physiological adaptations to polarized training compared with other forms of training.

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Reply

To the Editor:

Thank you for the opportunity to comment on the interesting letter from Daniel Boullosa and colleagues.[1] The concept of *polarized training* for endurance athletes is the focus of their letter, so it is appropriate that I recount its origin. I first introduced this term during an ACSM symposium lecture in 1999,[2] based mostly on observations of the training of elite endurance athletes in Norway. The first publications describing polarized training were based on the work of Fiskerstrand[3] and Kjerland,[4] who quantified the training characteristics of elite rowers and XC skiers, respectively. Concurrently, other published descriptions of the training intensity distribution of elite endurance athletes emerged showing that high-level endurance athletes often performed most of their large training volume well below their lactate threshold, as well as a significant portion between VT_2 and VO_{2max} intensities. That is, they seemed to polarize most of their daily training away from the range typically described as lactate threshold training. One explanation proposed for this pattern was that monotonous training loads, often centered around lactate threshold intensity, tended to induce staleness and symptoms of overtraining.[5,6] We proposed that training at intensities between VT_2 and VO_{2max} was an important but insufficient part of athlete preparation, but not a region of “adaptive conflict” as Boullosa et al speculate. It is also important to note that our description of the training intensity distribution extended only up to “100% VO_{2max}” and did not included sprint or strength training. We proposed that a potential consequence of this polarized intensity distribution was an acceptable balance between adaptive signal and stress response in the long-term training of endurance athletes. These issues are taken up in two recent reviews.[7,8] Mechanistic explanations for this pattern of intensity distribution in elite endurance athletes remain speculative.

Boullosa, Nakamura, and Ruiz propose a mechanistic connection between polarized endurance training and our evolutionary genetic heritage. They hypothesize that the self-organization of endurance training in elite endurance athletes along these polarized intensity lines has evolutionary links to hunting and gathering of low-to-moderate intensity, combined with occasional explosive bursts of energy expenditure (for both capture of prey and escape from predation?), as suggested to have dominated the exercise patterns of our ancestors. This is a very interesting hypothesis. Molecular evidence supporting such a link might come in the form of disproportionately robust cell signaling to both frequent bouts of exercise below the lactate threshold, and brief, very high intensity exercise, in combination with stress responses that are disproportionately elevated when exercise is performed in the lactate threshold range. It seems clear that future studies of athletes that integrate accurate descriptions of training exposure, resulting physiological adaptations, and time series quantifications of cellular signaling responses will be needed to test their ideas.

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Reply

To the Editor:

Although natural selection in the human genome accelerated during the past 40,000 years, probably less than 1% of our genes arose after the Paleolithic era.[1] Genetically, therefore, we are still hunter gatherers. “Long-time tracking persistence” (eg, ≤VT1), interspersed with very high intensity bouts (e.g. $\geq VO_{2max}$), was likely necessary for successful hunting and thus for survival.[2] It is thus tempting to assume that our genetic makeup is shaped for performing “polarized” endurance exercise tasks. How this genetically based hypothesis transfers to actual training prescription in elite athletes remains, however, to be determined. Elite endurance athletes are not representative of the general population because they have emerged from an *artificial* selection process. In fact, one of the authors (J.R. Ruiz) of the interesting letter by Boullosa et al nicely showed that world-class endurance athletes have a polygenic profile for endurance performance that differs from that of the general population.[3]

Genetics apart, we should rely more on observation and intervention studies performed in this group of highly selected humans. Even though from a global overview it seems useful to train in a polarized fashion, which includes training both “a lot” and “smart,”[4] the evidence seems to support that endurance improvements rely more on training intensity than on volume alone.[5] We should also keep in mind the “effective stimuli” training principle: less experienced athletes will benefit from training at a lower intensity, which may be lower than the specified intensity goal, whereas highly trained athletes will respond better to training regimens that are beyond the goal intensity.[6,7] The key question for producing a higher training response is not a result of utilizing one particular intensity; rather, it is more a result of working “below,” “at,” or “beyond” the goal intensity, respectively, for “novice,” “advanced,” or “highly trained” individuals.

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Reply

To the Editor:

One of the key tenets of exercise physiology is the principle of training specificity. Research findings suggest that training responses/adaptations are tightly coupled to the mode, frequency, and duration of exercise performed.[3] However, observations from world-class endurance athletes indicate that outstanding performances have occurred following training regimens that place little emphasis on competition-specific intensity. A model of "polarized" training has recently been proposed in which athletes undertake the predominant portion (approx. 75% of total training) at speeds or power outputs eliciting <2 $mmol \cdot L^{-1}$ blood lactate. The effectiveness of this model has been studied by Guellich and colleagues[2] and adds to previous work[4] documenting that elite endurance athletes from a range of sports, including rowing, running, cycling, and cross-country skiing, perform only a small portion of their training at competition/race-pace intensities, with the emphasis on low-intensity, high-volume workouts, and exposure to extreme high-intensity training sessions.

The findings that polarized training enhances endurance performance are not without precedent. Over a decade ago, we investigated the effects of different interval-training programs on simulated 40-km cycling time trial performance.[5] We found that interval training with work bouts close to race pace (8 × 4 min at 85% of peak aerobic power output [PPO]) significantly enhanced performance (2.8%, 95% CI = 4.3–1.3%). Yet, to our surprise, supramaximal work bouts (12 × 30 s at 175% of PPO) were just as effective in improving performance (2.4%, 95% CI = 4.0–0.7%). The apparent nadir in enhancement between 30-s and 4-min work bouts indicate that there is more than one mechanism by which interval training enhances performance lasting approximately 1 h.[5] We have also observed personal-best performances from world-class male Australian pursuit cyclists following 1–3 wk of stage racing (Martin DT, unpublished observations). Although the pursuit is performed at power outputs that elicit ~105% of maximal aerobic power (VO_{2max}) for ~4:15 (min:sec), ~80% of stage races are typically spent below power outputs equivalent to VO_{2max} and more than 90% of high-intensity efforts are <4 min in duration.[1,6]

While polarized training describes the distribution of training intensity, it is worth noting that the total time spent at race pace can still be substantial owing to the high overall training volume accumulated by most elite endurance athletes. Whereas specificity of training has received substantial attention, the concept of "specificity of fatigue" is less well understood. It is possible that elite endurance athletes deliberately avoid race-pace workouts before important events to maximize recovery/freshness as it relates to the specific demands of competition. Certainly, the unique genetic and/or molecular signature resulting from polarized training warrants further research.

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