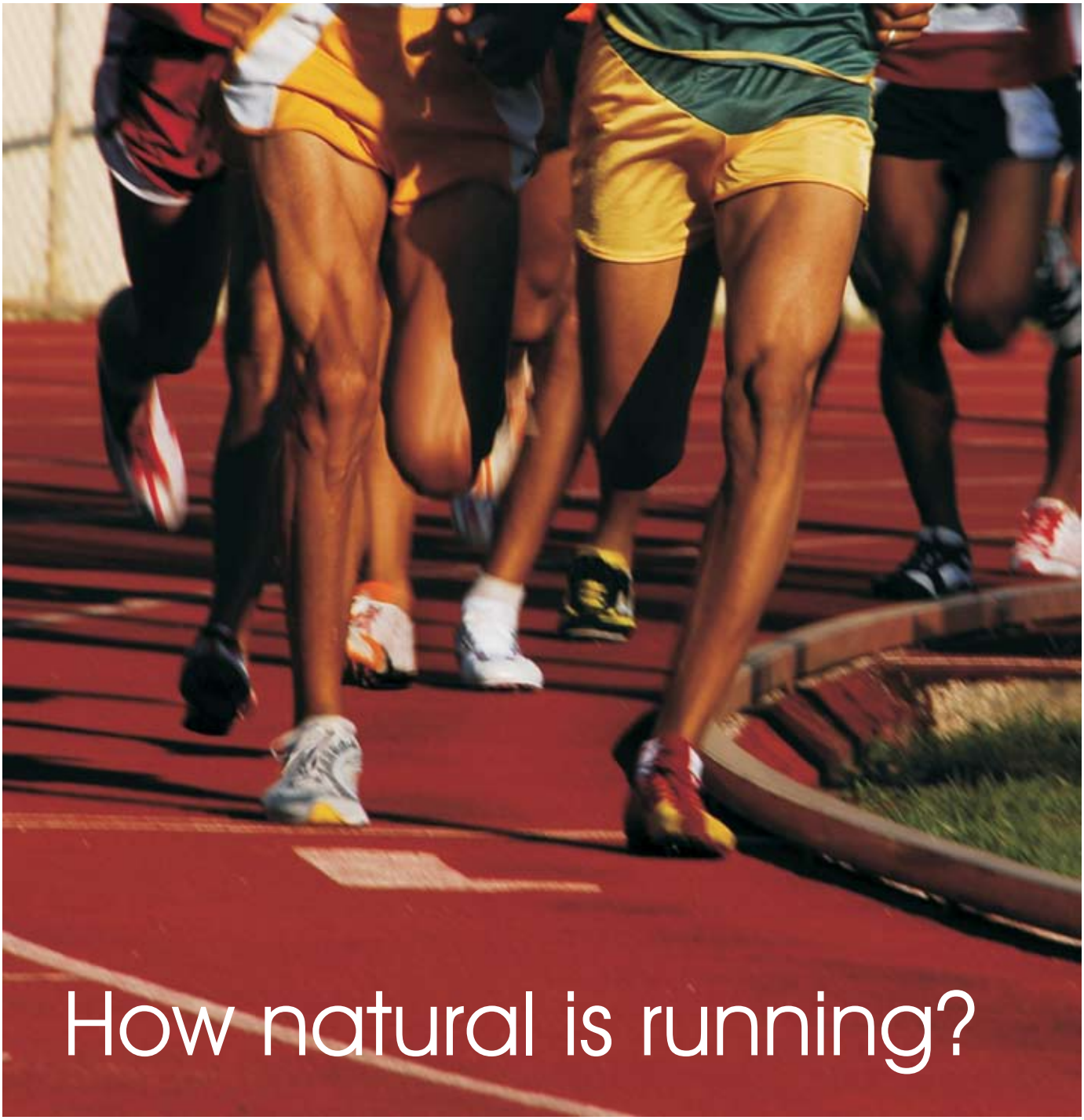

How natural is running?

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When we delve into the world of running it is easy to see that it is without a doubt, a very popular competitive sport in its own right and also a fitness activity used at all levels, from recreational gym routines to elite sports training programmes. In the world of nature, it is indisputably, the most natural and simplest form of locomotion and motion for us bipedal human-beings, learnt from a very young age and possibly without conscious motor control for most of our lives. But with this in mind, is running, in the sporting context, a natural phenomenon which only requires improvements in fitness to increase performances or decrease times, irrelevant of distances covered? And if this form of motion is so natural, why then do runners often suffer from various injuries or discomforts as a result of doing it? In this article we are going to briefly attempt to answer these questions from a biomechanical viewpoint and hopefully ignite a chain of thought that will be carried along into most different disciplines and sports for the benefit of all intending to improve their performances in the future.

Biomechanics can be defined as a field of sport science that applies the laws of physics and mechanics to human movement, or rather, the application of the principles and techniques of mechanics to the structures, functions and capabilities of living organisms. Biomechanical analysis is usually done in order to gain a better understanding of the quality of performance in athletics events, through modeling, simulation and measurement. Of vital importance is to have a basic understanding of how physics and its laws can be applied to sport, and the outcomes that could result from such principles as forces, motion, resistance, momentum, inertia, friction, drag, etc. Mechanical compensation and injury are also usually the result of various physical entities and can often be good indications of possible weakness, either in strength, stability or motor patterning. The biomechanics of running, in particular, can be thought of as the "technique" or "how to" component of the sport. Having good biomechanics is equally important to running well, as having a sound physiological foundation (high VO2 max, high lactate threshold, high aerobic capacity, etc.) and it is important to take into consideration how many running injuries are caused by faulty biomechanics.

Just like training your body to develop endurance, stamina and speed to run further at a faster pace, so too can you develop proper running technique during your training. Replacing ingrained bad habits with programmed good form is a four stage process. Stage one is referred to as "unconscious competence" – not thinking about what's being done correctly or incorrectly. This is how most runners cover their distances, not thinking or realizing about anything they are doing wrong. The next stage is "conscious incompetence", where there is a realization of what is being done incorrectly (possibly due to video analysis or coaching) and a conscious attempt to override "bad habits", but possible difficulty getting it right. "Conscious competence" follows in stage three, with a definite awareness of what is correct and the ability to run consistently with these corrected aspects, however, regular reassessment of technique is still required. The final stage is referred to as "unconscious competence". At this stage, all corrections to technique have been made, and after running properly for a period of time, basically becoming a habit requiring very little conscious thought.

Some runners have a smooth, flowing style of running while others are awkward; some hit the ground hard while others have soft landings; some are economical while others waste energy; some lift their knees high while others shuffle; some runners lean forward while others run upright. You can find runners with all these different characteristics in the same race and we often tend to copy the techniques of winners, resulting in ignorance of what could be a more effective technique for each individual. Its easy to say everyone has their own pace and runs with their own "style", which is true to a certain extent because your body can unconsciously decide what "feels best." However, this may not always be the best technique for speed and the reason is that you are not born with the correct running technique, it must be learned. Every runner has personal strengths and weaknesses and their running style should be built around those aspects.
With all this said, is there an ideal running form? It has been seen that runners with "improved" form often run less economically after the adjustments than they did with their "bad" form. To answer this question it is vital to understand what "good running technique" is, and to consider all parts involved in making this movement pattern possible.

Running can be seen as a series of alternating hops from one leg to the other (left to right leg). The ankle, knee and hip provide almost all the propulsive forces during running (apart from some upward lift from the arms). The running cycle comprises a stance phase, where one foot is in contact with the ground while the other leg is swinging, followed by a float phase where both legs are off the ground. The other leg then makes contact with the ground while the first leg continues to swing, followed by a second float phase. With this pattern in mind, it is easy to see that if the leg muscles are not strong or stable enough individually, that the entire movement will be affected. A simple movement like a one-legged squat often provides much valuable information pertaining to potential conditioning problems which decrease performance and possibly heighten injury risk. Any weakness or instability displayed during a one-legged squat would be heightened by approximately 3 times during running due to increased action-reaction factors during movement. The most common conditioning faults presented during such testing is weakness in the external hip rotators or glute medius particularly (which results in the inability to hold the knee stable and under the hip during loading, instead of collapsing or rotating medially) and weakness in the back & hip extensors or glute maximus particularly (which results in the trunk collapsing forward into slightly excessive hip flexion). Although these weaknesses arise from the hips, the potential injury risks are usually portrayed in the knees or ankles as these joints suddenly have to provide stability to a movement where they are not meant to provide stability, and certain muscles end up over-activating in compensation. The human body is amazing in the way it compensates for weakness

in movement by utilizing other muscles, or smaller movements, in order to complete the desired task. And this occurs without any conscious control at all. The problem with this amazing ability is that most often, compensation patterns become habits and the correct muscles are not utilized to their full potential, thereby hampering performance and increasing injury risks. In other words, despite running being a very natural and simple form of locomotion, it is vital to incorporate an individualized strength and conditioning programme to address weaknesses in order to optimize conditioning, reduce injury and maximize performance.

Apart from strength and conditioning, the two key components of running economy, and the two elemental aspects of running which must change in order to become a faster runner, are stride length and stride frequency. Improvements in fitness and physiological parameters will only increase the distance you are able to cover at your familiar pace, while increasing the speed at which you run can most often only be done by optimizing stride length and frequency. The easiest way to improve stride frequency is to take a look at your range of motion (ROM) used while running. Keeping the knees less flexed and the foot down at the level of the knee rather than pulled up close to the buttock during the swing phase creates a very long lever with a heavy foot dangling on its end. This lever then has to be swung forward for the next step and the longer the lever, the more effort is required to move it and the slower it can be moved. Rather, pull the knee in closer, essentially shortening the lever and making it easier and faster to move. When optimizing stride length it is important not to over-stride, as allowing the lead foot to strike ahead of the body's centre of gravity creates a braking force which leads to added resistance, and hence, increased effort to overcome. Rather than reaching out with the foreleg to get maximum distance during a stride, think about pushing back as hard as you can on each step, using the gluteal and hamstring muscles to do so. ***Run from your hips – not from your knees!*** In summary, three great ideas for technique improvements are better quadriceps flexibility to increase ROM, increased knee flexion during the swing phase and heightened backward pushes with the hamstrings and gluteal muscles. It is important to note, however, that while slightly more flexion is good during the swing phase, excessive flexion during the stance phase is bad as these joints have to be straightened back out again at toe-off, requiring more energy and increasing the time spent in contact with the ground (footstrike).

When looking at the upper body, the main function of the arm action is to provide balance and promote efficient movement. In the forward horizontal plane the arms and trunk move to oppose the forward drive of the legs; during the braking phase (heelstrike to mid stance) the arms and trunk produce a propulsive force and during the propulsion phase (mid stance to toe-off) the arms and trunk combine to produce a braking force. This may seem a little weird, but in fact it is an advantage: the out-of-phase actions of the arms and trunk reduce the braking effect on the body and so conserve forward momentum. In the vertical plane around the centre, the arms and upper trunk oppose the motion of the pelvis and legs, i.e. as the right knee drives up and through in front of the body – producing an anticlockwise angular momentum – the left arm and shoulder move forwards – creating a clockwise angular momentum and counteracting the knee motion, thereby helping to reduce rotation forces through the body during the whole gait cycle. Although the legs are much heavier than the arms, the shoulders are wider than the hips, so the arms are well positioned for their job of counterbalancing the leg rotation. This may explain why female runners use a slightly wider or rotating arm action to compensate for their narrower shoulders and lighter upper body. The arm action has more to do with running efficiency than with injury prevention directly. A good arm action needs to be encouraged to counterbalance lower-limb forces and angular momentum, which may in turn help reduce injury. It also contributes a little to the vertical lift during the propulsion phase which may help the runner to be more efficient, reducing the work done by the legs. An analysis of running technique is most easily done using a video camera so that the film can be slowed down and played back at a fraction of the speed – thereby making it easier to detect problems or potential performance restrictions in technique. Visual and biomechanical feedback also makes the athlete more aware of what exactly they are doing in their running and where their strengths and weaknesses are. Correcting pitfalls is then much easier as they have a solid foundation or idea to work from.

In summary, despite various "style" differences between runners, there are certain key basics that need to be incorporated into all running techniques in order to be as economical and efficient as possible, as well as to avoid injury. The key factor to keep in mind is that the goal in running is to go forward (usually as quickly as possible depending on distances to be covered), and in order to do that, all the individual movement used should have a positive effect on that goal, without wasting energy on additional, and most often fatigue causing secondary movements. In terms of conditioning, stability is key to efficiency, and the hips and gluteal muscles are KING!!!