
illustration by Nate Dyer

After hundreds of thousands of years, you might think that we as a species would have our physiology down pat. The process of working hard, recovering and getting stronger seems almost instinctual these days, even if in many ways its application to running is somewhat recent. Yet if science has shown us anything since the days of Descartes, it's that one minute's moment of genius insight ("Drink as many fluids as you can in a marathon") is the next moment's blunder ("Drink too much water and you could die of hyponatremia"). Science, it seems, is an evolving art.

The process of heat training and acclimatization is no exception. Ever since Italian marathoner Dorando Pietri collapsed near the finish line at the 1908 Olympics (never mind Alberto Salazar being read his last rites after the Falmouth Road Race in 1978), caution has been the keyword used when discussing how to tackle hot and muggy conditions. Train early, train slower and train with lots of fluids on your back has been the advice passed down now through many a running generation. But like all conventional wisdom, there comes a time when the basis of that wisdom needs to be re-examined.

Particularly after what happened in a University of Oregon lab.

MYTH # 1: Training in the Heat Helps Only With Hot-Weather Running

Several years ago as a doctoral student at the University of Oregon, Lorenzo Santiago noticed a large gap in the exercise physiology literature. While many studies had looked at the benefits of heat acclimatization when competing in warm-weather events, no one had checked to see if there was any carryover effect when those acclimatized individuals were placed in cool conditions.

A former NCAA champion and Argentine Olympian in the decathlon, Santiago enlisted 20 elite cyclists and put them through an identical training regimen, but for one significant difference: One group rode easily for 90 minutes (50 percent of VO2 max) at a comfortable temperature of 55 degrees; the other group rode at the same intensity in a heat chamber set at 104 degrees. The cyclists did ten of these sessions. Both groups continued their normal training outside the lab. After the test period, the groups did all-out rides in the two environments. As expected, the heat-trained riders performed better than the control group in the heat chamber. The real surprise, however, was when both groups were tested in the 55-degree chamber: The heat-trained cyclists outperformed the other group by an average of 7 percent.

"It was quite remarkable, given these athletes were well-trained to begin with," Lorenzo says.

"Riding at 50 percent VO2 max is pretty easy, so it was just [training in] the heat that caused the adaptations."

illustration by Nate Dyer

Across the board the heat-trained riders showed gains in the measures all runners hope to improve: VO2 max, lactate threshold, maximal cardiac output, maximal power output and 1-hour time trial performance. Yet the only piece of the training that varied was the exposure to heat. The magnitude of the effect was similar to altitude training.

Now a fellow at the Institute for Exercise and Environmental Medicine in Dallas, Santiago eagerly awaits the next phase. "I'm really hoping this will spark a new line of research," he says. "Maybe we can transfer some of these lab results that we've found to real-world competitions." The big question, he says, is, "Do we still see these improvements when they run a marathon?"

While the exercise physiology world awaits further studies, anecdotal evidence backs Santiago's findings. Case in point: Benji Durden. After a poor race at a warm 1977 Boston Marathon, Durden was invited to compete in Puerto Rico that summer. Not wanting to repeat his Boston performance, Durden started training in a T-shirt during the hottest parts of the Atlanta day to acclimatize. Then he added more T-shirts.

"Long story short, I won the race," Durden says. "I thought I was just training better. After I took off the T-shirts, I started slowing down a little bit again."

With the backing of esteemed physiologist (and sometime training partner) David Martin, Durden started pushing the heat training limits first laid out by Leonard "Buddy" Edelen, the last American-born world record-holder in the marathon. Durden ran in alternating layers of Russell sweatshirts and waterproof rain jackets; he added a Po2 tank, a contraption that used soda lime to scrub out carbon dioxide from the air. All of this, he believed, gave him a leg up on the competition.

"I did all my runs except my speed work [in these outfits] and then I'd put them right back on," he says. "And I was doing my speed work in the middle of the day. So I got very, very fit and very efficient at running in the heat." Durden went on to career highlights of a 2:09 marathon in 1983 and a second-place finish at the 1980 U.S. Olympic marathon trials.

"Was it the heat?" Durden asks. "Was it running with an extra 15 pounds on my back? Who knows?" Santiago's findings would imply Durden's success could be attributable to the warm weather. Still, Santiago cautions that, before everyone runs out and starts training in sweat suits during the middle of the day, more research needs to be done. Potential risks exist from training hard under the warm sun, especially in relation to hydration. Right?

MYTH # 2: The Thirst Mechanism is Flawed

Much has changed in the past eight years. It was then that the American College of Sports Medicine (ACSM), incensed by a report in the British Medical Journal that challenged their fluid intake recommendations, issued a rebuttal. In it they wrote: "ACSM experts contend that thirst alone is not the best indicator of the body's fluid status. Dehydration resulting from the failure to replace fluids during exercise can lead to impaired heat dissipation, which can elevate body core temperature to dangerously high levels." The results of not replacing this fluid, they went on to say, would lead to an increased risk of "heat exhaustion, heat injury and exertional heat stroke." The writing seemed to be on the wall: hydrate or else.

Today the guidelines have been revamped. After performing a thorough meta-analysis, Loyola University's Jonathan Dugas, a well-known blogger on the Science of Sport website, explains why. "I'm not saying there's no effect of fluid on body temperature, but you have to really qualify it," he says. "The effect is really small. Maybe a half degree in temperature, maybe less."

Current ACSM guidelines recommend drinking enough on the course to limit fluid losses to 2 percent or less of your body mass. "If you're losing more, you're not drinking to thirst," Dugas says. "That's going to slow you down. By how much, I don't know. Depends on the environment, depends on your level of fitness, depends on your acclimatization."

To assess the magnitude of dehydration's effect on performance, Eric Goulet, Ph.D., of Sherbrooke University in Quebec, looked at five studies that had athletes perform time trials at various stages of dehydration. His findings, released in the April edition of the British Journal of Sports Medicine, contend that not only is drinking to thirst the best method of staying hydrated, but those who drank less or more than their thirst mechanism indicated performed poorer in the time trials.

Despite these findings, good hydration is the best method of avoiding heat illness, right?

"Heat illness is a bogus term," Dugas says.

"It's a totally ambiguous term." His research suggests hydration levels have almost no effect on one's likelihood of suffering from even the most extreme of all heat-related issues, heat stroke. "The consensus is we don't really know that much about heat stroke. We can't test it. And the problem is we're confined to saying, 'Hey, there's a heat stroke case over there. Go measure

him.'" Current research suggests that some combination of genetic predisposition, infection, muscle damage, sleep deprivation and high levels of exertion may lead to heat stroke. But, as Dugas adds, plenty of athletes present with these problems and never develop heat stroke. In either case, water intake (or the lack thereof) isn't mentioned.

These findings aren't to imply that hydration is unimportant. If anything, fluid remains one of the cornerstones of performing well in any environment. The problem is too many preconceived notions about hydration are inaccurate.

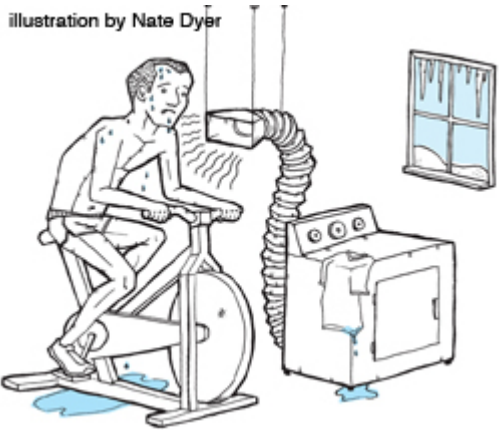
illustration by Nate Dyer

"If you run a long race, something like a marathon, and you have no access to fluids, here's what's going to happen," Dugas says. "Your performance would be affected because of your body temperature rising slightly [due to no fluids]. But you wouldn't get too hot--you would slow down. The magnitude of that performance detriment is 1 to 3 percent" when compared against those who drink to thirst. The body, in other words, will self-regulate given the conditions.

"On a very hot day," Dugas says, "no amount of drinking is going to change the fact that you're going to go slower. You can drink up to 100 percent of your body mass, and it won't keep you from running slower."

One concern Dugas sees is that people confuse the ideas of fluid balance and volume replacement. Fluid balance is the key to maintaining performance.

"I'm not sure what people think of when they think of fluid balance, but I suspect they imagine it like a scale where losses equal gains," he says. "That's where people need to change their thinking. Being fluid balanced means you keep that fluid concentration the same inside and outside the cells." Drinking even half of what you sweat out during a race will accomplish this goal, a wonderful revelation for those who have suffered bloated runs for far too long.

MYTH # 3: Acclimatization for a Warm-Weather Race is Impossible if You Don't Live in a Similar Climate

In the winter and spring of 2000, Todd Williams built a torture chamber in his basement. Already an Olympian at 10,000m in 1992 and 1996, Williams eyed a spot on the marathon team for the 2000 Olympics in Sydney. To get there he would first have to place in the top three at the trials held that May in Pittsburgh. Despite living in the already hot and humid climate of Knoxville, Tenn., Williams believed his best shot at acclimatizing was to simulate even worse conditions in his basement.

"I bought a Precor treadmill that could do everything," he says, "and I just cranked it. Pretty much 80 degrees and make it steamy, crappy as possible."

Williams had done his research and knew that Pittsburgh springs could get exceptionally muggy. On one hand, he sought to acclimatize his body as best as possible by simulating the conditions. Then there was the other hand.

"I don't recommend this for that many people, but I just tried to torture myself," he says.

"Distance running was comfortable for me, and to try and get to the next level you had to learn how to deal with feeling like crap. So I would do whatever I had to do to make my training environment really, really tough."

Perhaps no race conditions are as tough as those of the Badwater Ultramarathon. Held every July, the race takes competitors from the low point in Death Valley to the base of Mt. Whitney, a 135-mile odyssey whose conditions are so extreme they seem impossible to prepare for. Yet

each year people from areas as disparate as Wyoming and New York meet the challenges just fine.

"I try and wear more clothes to get that feeling [of Death Valley]," says Lisa Smith-Batchen, a two-time winner of the event who ran across the U.S. last year. "I sometimes drive with the heat on to get used to that suffocating feeling. I tell people if they want to know what Badwater feels like to go put their heads in a pizza oven."

Or a laundry appliance. That's what Kirk Johnson, a writer for The New York Times, found out when he was doing research for his book on Badwater, To the Edge. "There was one guy who hooked up the blower from his clothes dryer and would ride on the stationary bike with it blowing on him," he says. In his efforts to acclimatize, Johnson often spent time in a sauna doing moderate exercises. "What made the most sense to me was the most exposure possible."

illustration by Nate Dyer

To fully acclimatize to an environment, one needs to exercise in a similar environment. Not everyone has access to a sauna, of course. And the idea of running around the neighborhood in three layers of sweatshirts on a hot day sounds like hell to most. For those souls, hope still exists.

"In some ways becoming better trained is like becoming heat acclimatized," says Dugas.

"People fixate on this, thinking that it is going to make all the difference, when really they should be putting that time and energy and focus into their training, which is by far the biggest predictor of success for the recreational athlete."

MYTH # 4: Wear as Little Clothing as Possible When Running in the Summer

There's perhaps no time runners receive more taunting than when they run almost as Mother Nature intended. We're talking short shorts and no shirt for the boys, sports bras for the girls. Something about shedding layers seems to incite passersby to whistle or make crass remarks. It's a small price to pay for running in the proper summer attire, right?

Maybe not. Witness an event like Badwater, and you're likely to see people in varying degrees of covering--from lightweight, long-sleeve shirts to Mylar-covered sun suits that look like astronaut attire--even when the temperature reaches 130 degrees.

"That desert wisdom, to reflect back away from your body as much radiant exposure as you can, really made sense to me," says Johnson, who wore a sun suit when he competed at Badwater in 1999. Smith-Batchen follows a similar philosophy, despite feeling like she was suffocating in the sun suits after wearing them on her first several Badwater runs. "For a few years now I've worn a silk, lightweight material," she says. "I like to cover my skin when the sun is beating down, but then at night I try and get as little clothes on as possible."

While long-sleeve options will probably never catch on as a fad in the summer, compression gear certainly has. For fans of compression gear, wearing it in cold weather is a no-brainer. But what about when it's hot? Does the tightness of the gear trap more heat than conventional clothing such that, at some point, any compression benefits are outweighed by heat considerations?

The science on compression wear is still in its early phases. A 2010 Australian study found that those wearing compression gear in warm conditions performed moderately better in a time-to-exhaustion test than those wearing regular garments, but that it had no discernable effect on VO2 max, pulse rate or other physiological factors like core temperature. A similar study from 2009 found no effect from wearing compression garments except higher skin temperature. Both studies

concluded training in these garments was safe regardless of the environmental conditions.

All of which means that if you enjoy the feel and wicking ability of compression gear, don't hesitate to wear it during the summer. Your skin may feel a little toasty, but your insides will cool as effectively as before. Just don't be surprised when you still get honked at.

MYTH # 5: Hyperhydration (or Water Loading) Is Impossible Leading Up to a Warm Race

The kidneys are good at their job. Really good. One of their key tasks is removing excess fluid from the body. Which means, on paper anyway, that drinking copious amounts of fluid in the days before a key hot weather race will do nothing to improve water-storage capabilities, right?

illustration by Nate Dyer

Though Dugas and Goulet have proven a moderate amount of exercise-induced dehydration has little to no effect on performance, there are situations (such as a hot weather race with no access to fluids) where having additional fluid stores might prove advantageous. "While resting there is nothing that can be done," says Goulet. "You have to remember that the body will do anything it can to maintain its homeostasis. But you can fool it by hyperhydrating only a couple of minutes prior to starting the exercise."

Hyperhydrating, or drinking more fluid than is necessary to maintain fluid balance within the body, is effective right before an event because blood flow is severely reduced to the kidneys during exercise, thus limiting fluid excretion. "The trick then is to be able to absorb quickly and then tolerate the bloating feeling for a couple of minutes into the exercise period," says Goulet. "As the exercise progresses the intestine will slowly absorb the fluid, which will then be used for physiological regulation."

But what if there were a way to hyperhydrate hours before an event?

For the past two decades the most promising branch of research centered around the substance glycerol. When mixed with water in varying degrees of concentration, glycerol promoted greater fluid retention in the body. Companies such as Hammer marketed solutions that, in theory, would allow athletes to drink less water on the course while remaining hydrated and also feeling the urge to urinate less (a big bonus for marathoners). However, its potential as a drug-masking agent led the World Anti-Doping Agency to ban glycerol in 2010.

Today sodium-induced hyperhydration is the most promising development. Currently in the testing phase at Sherbrooke, Goulet says, sodium-induced hyperhydration--essentially, drinking lightly salted water in the several hours preceding hot weather exercise--is clearly showing that it produces as good if not better results than glycerol-induced hyperhydration. The biggest trick, Goulet concedes, is making the substance palatable. For his trials, Goulet had the salt water (just over ¼ teaspoon of table salt per cup) blended with Crystal Light and served at roughly 35 degrees, but adds, "You have to find what works best for you."

Regardless of your goal, hyperhydration makes sense on a practical level only if you anticipate not being able to keep your fluid losses to less than 2 percent of your body mass, Goulet says. Otherwise it probably makes sense just to squeeze in a few extra sips on the starting line.

MYTH # 6: Heavy Sweaters Are Screwed

Even after murderous long runs in his torture chamber basement, Todd Williams didn't win the 2000 Olympic marathon trials. In fact, on a sweltering day in Pittsburgh, he didn't even place in the top three. His Olympic dream ended that day.

"Ten miles in I was sweating through my shoes where you can hear that sponge sound," he says with a laugh, "and I still had 16.2 miles to go." Williams went into the race concerned about his high sweat rate but figured there was nothing he could do. "I was 100 percent confident in my training," he says, "but not in my body's ability to withstand the race conditions."

Interestingly, some scientists have attributed Sammy Wanjiru's gold medal in Beijing to a high sweat rate. "When he ran that 2:06, no one thought that was [possible] because the conditions were so hot," says Dugas. "One of the ways you can explain that is he either has to be producing [significantly] less heat or he must be better at getting rid of the heat he does produce. The one way you can be better is by producing more sweat. The hypothesis is that maybe the best of the best have higher sweat rates than their peers, and this would allow them to perform better at highest intensities, especially in warm temperatures. But that hasn't been tested."

While this initially sounds promising, the reality isn't quite as nice: Wanjiru and his ilk may not sweat the same as you or I.

"Probably what's allowing [elite athletes] to sweat more is that the point to which it's regulated to is different," Dugas say. "That would allow them to sweat longer, so to speak, before they start to get thirsty. That'll lead to them needing to ingest less fluids to maintain their fluid balance."

For us non-elites, a relatively heavy sweat rate might just mean getting to that critical 2-percent-loss threshold sooner than others and having to slow. So what's a heavy sweater to do? Athletes and scientists have experimented with any number of methods. "What I tell people is, 'Once you

find the magic that works for you, stick with it," says Smith-Batchen. "We are all so uniquely different. It's all trial and error." In her racing at Badwater, Smith-Batchen sips water every two minutes and keeps ice packs on her main arteries. Dugas recalls recent research that had lab subjects stand in front of a fan while being doused with water; the results show it effective in lowering the amount of stored heat in the body, if not practical come race day. The ACSM recommends salty foods or beverages with sodium prior to competition to help retain fluids in the body. And fuel belts and handheld water bottles continue to rise in popularity as on-the-go hydration needs are further embraced by the mainstream running crowd.

Yet for all the cooling devices and bits of advice floating around out there, trying to alter your own sweat rate may be a futile act. Or, as Goulet says, "I will not try to circumvent Mother Nature on that one."