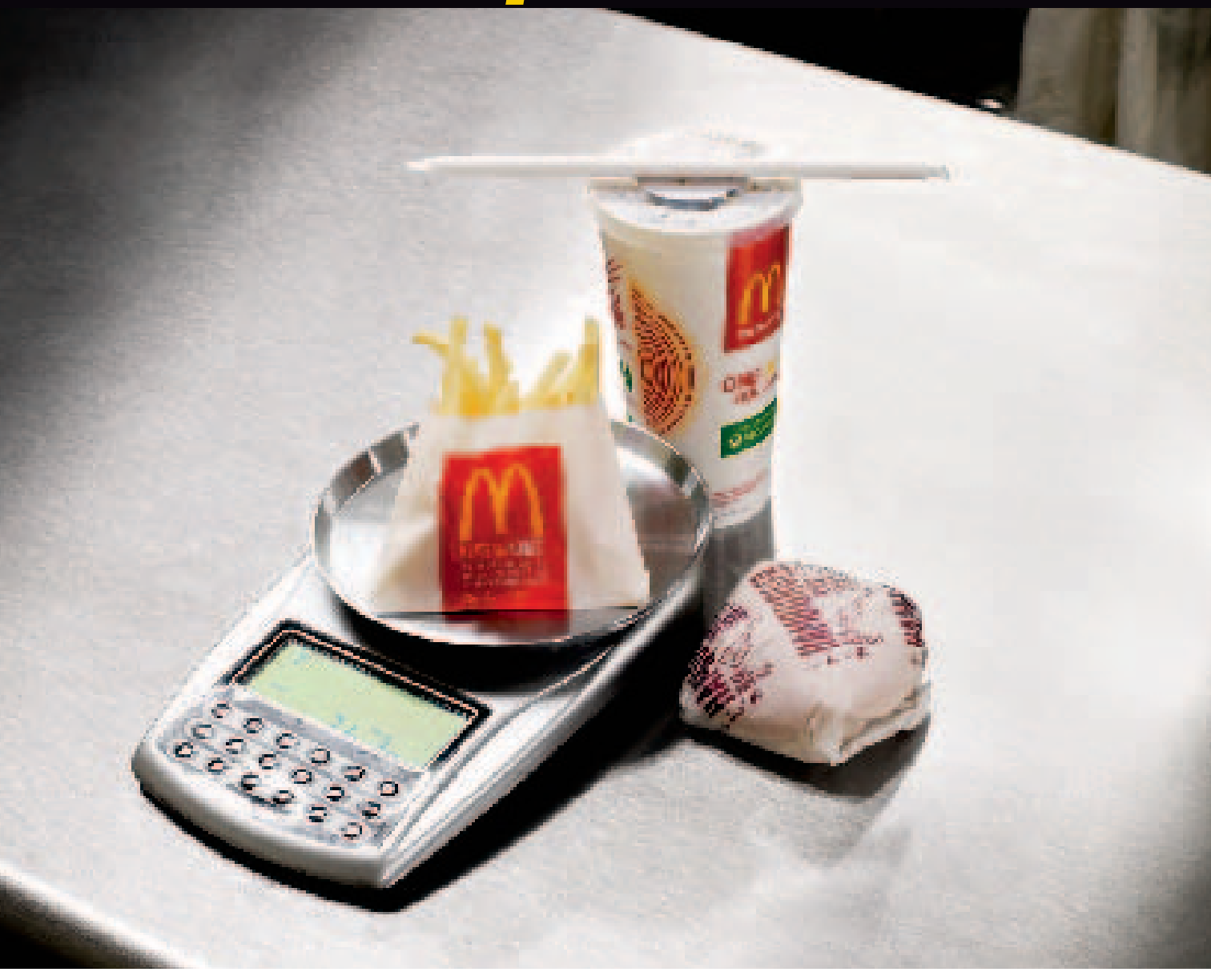
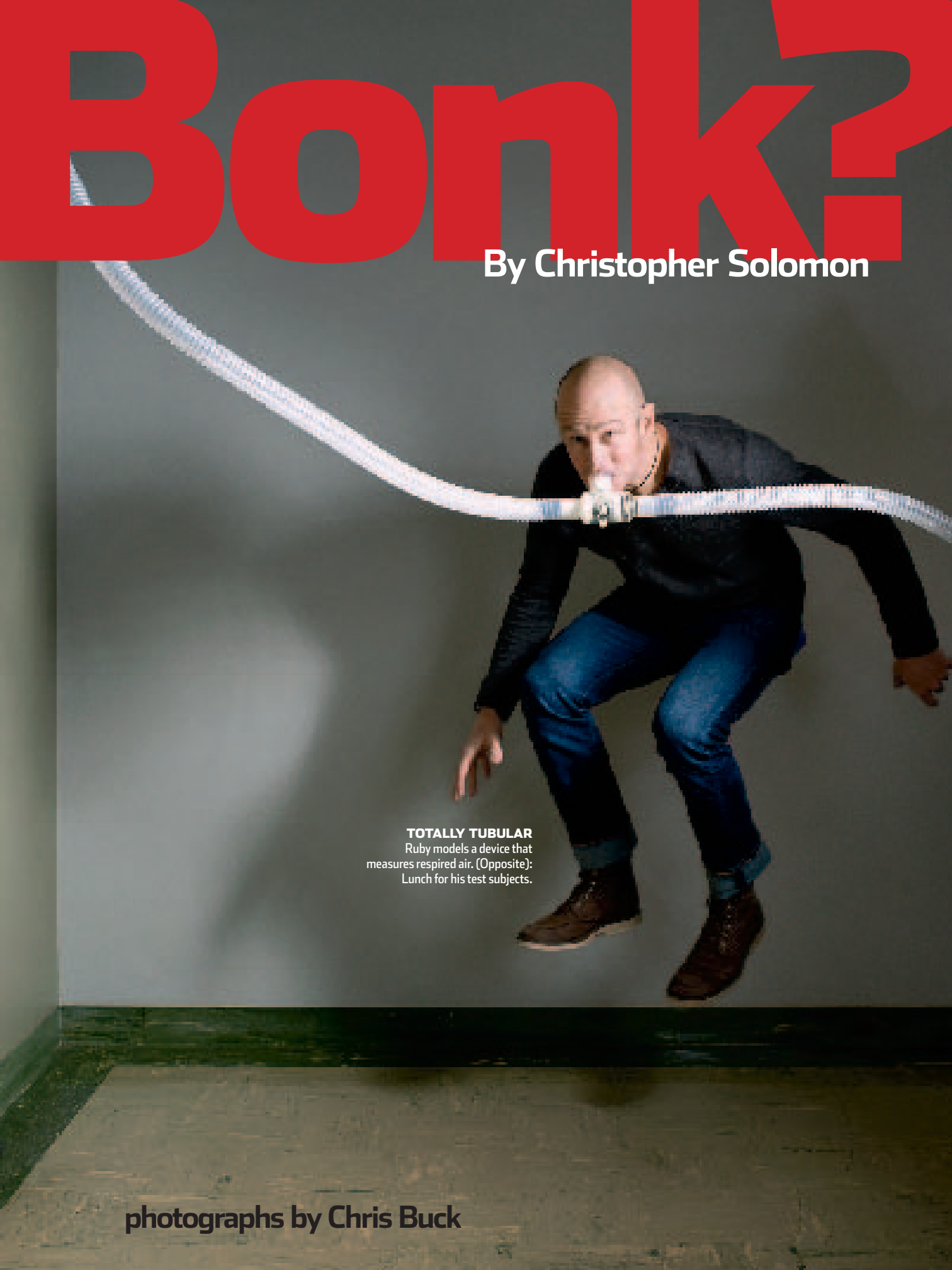
You want *fries* with that



Step into **Dr. Brent Ruby**'*s lab, and prepare to work—hard. His obsession? Using odd experiments—including testing fast food as fuel—to redraw the limits of human exertion*

Bonk?

By Christopher Solomon



TOTALLY TUBULAR
Ruby models a device that measures respired air. (Opposite): Lunch for his test subjects.

photographs by Chris Buck

"It will sting like a bee at first," the professor says as he takes a pinch of leg and slides the first needle just below the skin. Now comes the second hypodermic—more lidocaine, to anesthetize the spot. Within a minute my outer thigh muscle is so numb I don't feel his scalpel when it slides in, making a half-centimeter incision.

"What happens now?" I ask, not eager for the answer.

The final needle that Brent Ruby, Ph.D., holds up looks like something that Wile E. Coyote would buy from Acme. Its business end could be a drinking straw. "Walt's gonna suck it out," Ruby says. Walt is Walter Hailes, Ruby's colleague. "It" is my flesh.

Ruby is an exercise physiologist at the University of Montana and director of a research center on campus dedicated to maximizing human performance—a charismatic, Ironman-running, kilt-and-cowboy-hat-wearing grinner who is partial to fast runs and surfing on stand-up paddleboards he crafts by hand in his workshop. I've volunteered to play pincushion for him because over the last 15 years, Ruby has made a name for himself both thanks to, and sometimes in spite of, his creative and contrarian approach to questions about the human body's capacity for endurance, and to how it recovers and rebuilds—whether it's marathoners, wildland firefighters scratching a fire line in 100-degree heat, or Air Force Special Ops personnel.

The study that now has me squirming on the exam table is classic Ruby. Much work in recent years, Ruby explains, has studied what we should eat for quick, optimal recovery after hard workouts (chocolate milk, anyone?), and a whole industry of "sexy solutions" like $2.50 chocolate Gatorade G Series Recover 03 Protein Recovery Shakes has sprung up around recovery. "I don't buy that at all," he counters. The body has evolved to be really smart, he says; it can quickly grab and utilize the same macronutrients it needs—carbs, protein, fat—even from seemingly low-quality chow.

This explains the sacks of McDonald's fast food congealing in the other room.

"We thought, *Why don't we go the most extreme and try the foods that people don't think are a recovery food at all, that are widely available?*" he says. "*Will that have the same impact in terms of both muscle recovery and performance?*"

The answer, the professor thinks, is yes.

To test their hypothesis, Ruby and his colleagues are tiring out guys like me on a stationary bike, feeding us two Golden Arches meals as we rest, then seeing whether we perform just as well on a vigorous ride in a few hours as we do on another day when we recover by gulping a variety of highly formulated sport supplement products like energy bars and Cytomax sports drink.

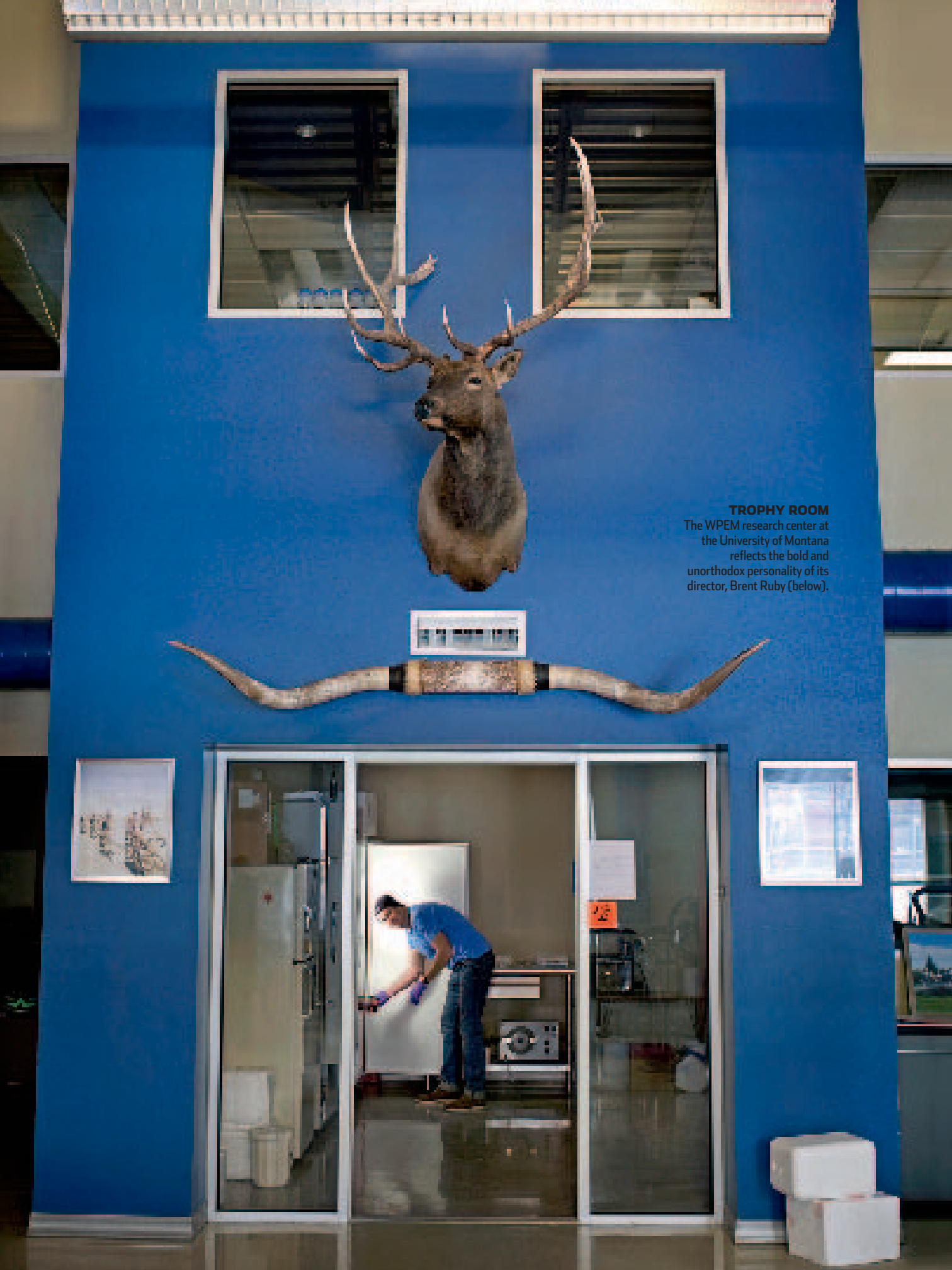
Ruby clearly relishes putting Ronald McDonald at the training table for another reason, too: to tweak popular dogma, and to throw a wrench into the churning hype engine. "There's the strategy of just falling in line and becoming a good consumer of the research that's been done for many, many years," says Ruby. That's not his way. "My mind is not the typical scientist mind," he says. "It is riddled with the desire for creativity, and poetry and imagination." The scientific method may be rigid, but the questions you ask—and how you ask them—don't need to be rigid at all, he says.

Back at the exam table, Ruby pushes the cartoon needle into my right thigh. Hailes pulls on a suction plunger. Soon a tiny pink blob quivers in a petri dish: human sashimi. These muscle biopsies give a snapshot of what's happening in the muscle at that moment, including how much glycogen, or stored sugar, the muscle contains—simply put, how much fuel is primed and ready in the tank.

The professor crochets a stitch in my thigh, slaps a bandage on it, and sends me off. Another victim is waiting for his meat to be harvested. And I've got a date with some pancakes and greasy hash browns.

Ruby is an Ironman-running, kilt-and-cowboy-hat-wearing grinner partial to fast runs and stand-up paddleboards.

On a brittle morning last November in Missoula, I met Ruby and we walked over to the research center on campus. Ruby, 46, looks nothing like a pointy-headed university researcher, an impression he would take as a compliment. He is tall and lean and muscular, with a clean-shaven head beneath a knit cap that together mask a backpedaling hairline. The defining features of his face are a thick soul patch and a large smile. When Ruby laughs, which is often, the corners of his brown eyes wrinkle into deep brackets. He is a stylish dresser and always wears one item—bright socks, or a paisley shirt—that asks for attention; today a pair of slim jeans were riveted in place by a belt buckle the size of those usually awarded to rodeo champions. Ruby and his 16-year-old son, Zeb, had recently returned from watching his wife, Jo, run the New York City Marathon. (Zeb, fond of climbing and board sports, and his 19-year-old sister, Ellie, a runner, hold their own as athletes.) Ruby had stood along the marathon route, dressed in a

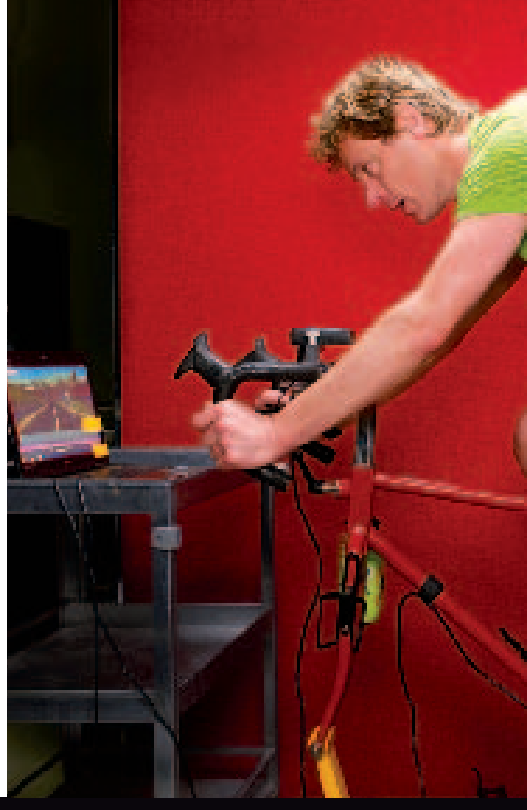


TROPHY ROOM
The WPEM research center at the University of Montana reflects the bold and unorthodox personality of its director, Brent Ruby (below).

Montana cowboy hat and that belt buckle, and for hours had rung a 35-pound Swiss cowbell. Marathoners stopped to take pictures of *him*.

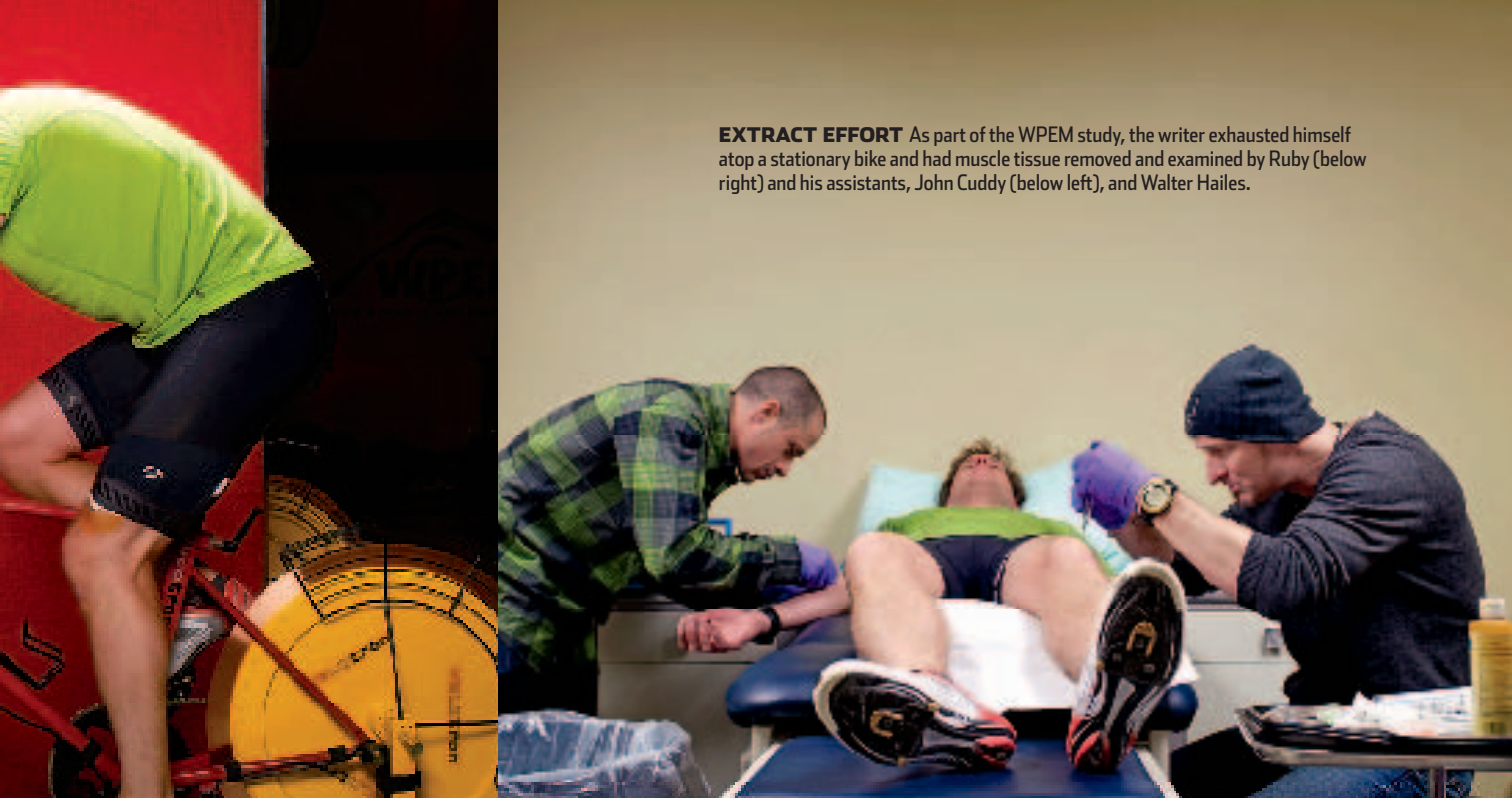
Ruby's lab is officially called the Montana Center for Work Physiology and Exercise Metabolism (WPEM, pronounced "whip 'em") and occupies a modern annex amidst a campus of sober, red-brick buildings about 150 yards off the university's main quad. He unlocked a door marked "biohazard" and we stepped inside. I'd expected to find treadmills and stationary bikes, and I did. As Ruby switched on the radio and the Rolling Stones' "Gimme Shelter" filled the rooms, however, the resemblance to other sterile exercise-science research centers I'd visited vanished. Two massive trophy elk heads gazed down forlornly from the walls. Lamps and mobiles created from used bicycle parts by Ruby (he has sold his artwork in Missoula galleries) spun languidly as the heat circulated. A photo of Ruby riding naked atop his 1889 high-wheeler, one of those comical Victorian bicycles with a five-foot front wheel, hung upstairs in a hallway. Everywhere was the flotsam of the perspiration-driven life: cartons of heart-rate monitors and energy bars, a peloton of road bikes hanging like bats in the rafters. The whole place was odd and wonderful and of a piece with its director—think *Pee-wee's Playhouse* meets Bill Nye, the Science Guy, if Nye was a six-time Ironman finisher (as Ruby is) or could run a 2:10 in the 800 meters, or a 4:49 mile, as Ruby did at the USA Masters Indoor Track & Field Championships last year, placing third and fifth, respectively.

John Cuddy, 32, one of the center's two senior research associates, arrived and gave me the mini tour. Ruby is the mad-scientist-in-residence, rainmaker, and public face of the research center's close-knit team. Cuddy and the 34-year-old Hailes—the former an avid hunter and runner, the latter a mountain guide who owns the local climbing gym—run most of the studies and day-to-day operations. Behind a glass door lay a biochemistry lab full of test tubes and machines like spectrophotometers where the team can analyze blood, muscle, saliva, and urine to look at changes in the body under stress. Next Cuddy headed over to what appeared to be a walk-in freezer. "Here's our environmental chamber," he said; it's one of the few such chambers in the country. "We can go from negative 10 degrees to 50 degrees centigrade [or 14 degrees Fahrenheit to about 122 degrees] and we can go from sea level to 18,000 feet [of simulated altitude]. So we can mimic nearly any environment in the world." Inside the chamber hung what looked like those heat lamps that warm turkey tetrazzini in a school cafeteria. "It even has infrared lights," Cuddy said, "so we can imitate sunlight" and help boost the temp to nearly 135°F. The next day when I showed up, a grad student was braising a runner in the chamber as part of his Ruby-guided master's thesis: Does drinking an ice slushy during exercise in the heat slow down the rise in body temperature and make the runner feel better, and therefore help him keep going? Faster, higher, farther—but safer. That's WPEM's goal. Within that, Ruby & Co. have chased human performance in all sorts of directions, following Ruby's eclectic and curious mind—exploring everything from how to feed people smarter, and train them better, to how to help them cope better with extreme environmental conditions. Much of the research center's funding has come from the U.S. military, which is constantly trying to build a more vigorous soldier, but the results often speak to the rest of us. After all, as Ruby likes to point out, a Navy SEAL and a marathoner trying to qualify for Boston aren't so different: Both are high-performance athletes working out under pressure for hours, often under intense conditions.



The team found that athletes at the Western States 100-mile run burned 16,000 calories, or, Ruby says, "30 Big Macs."

Behind the research center sat two solar-powered Airstream trailers-cum-laboratories, rolling symbols of the unusual niche that Ruby has created for WPEM: taking hard science out of the climate-controlled setting and into the field to test "free-range humans" at work and at play. "In four months last summer, we took them to the lowest paved road in the Lower 48 and the highest paved road," Ruby says of those Airstreams, a bit of pride in his voice. The former trip was to Death Valley to measure the heat tolerance of ultrarunning legend Scott Jurek for a Weather Channel show. The latter was to test runners gasping on treadmills in the stingy air of 14,000 feet atop Colorado's Mount Evans while doing work for the Department of Defense's DARPA, the federal government's Skunk Works, which wants to come up with a pill combo that will minimize the negative effects of exertion at altitude. ("No luck yet.")



EXTRACT EFFORT As part of the WPEM study, the writer exhausted himself atop a stationary bike and had muscle tissue removed and examined by Ruby (below right) and his assistants, John Cuddy (below left), and Walter Hailes.

Over the years Ruby & Co. have also studied Iditarod dog mushers in Alaska and climbers on Alaska's 20,320-foot Denali (Mount McKinley) and Washington state's Mount Rainier. "Some of his ideas are a little out there," Robert Kenefick, Ph.D., a research physiologist in the thermal and mountain medicine division at the U.S. Army Research Institute of Environmental Medicine, wrote of Ruby in an e-mail. Still, Kenefick likes Ruby the man and the scientist. "He is very creative and inquisitive," Kenefick wrote. "I would describe him as an idea machine."

What first caught my eye about Ruby's work, though, was the statistics. Several years ago as a young academic he started to put numbers to outsized human effort. Building on his early work for the military on the caloric needs of wildland firefighters, good standins for soldiers, Ruby used a clever method involving monitoring the movement of stable isotope tracers in water—like sweat or even tears—to get the most accurate estimate yet of how much energy athletes burn in endurance events. Athletes at the Ironman World Championships: 8,000 to 9,500 calories, on average. (A big day on the Tour de France, by comparison, might require 7,500 calories.) The Western States 100-Mile Endurance Run: 16,000 calories. "That's almost 30 Big Macs," he tells grad students in a seminar one afternoon in Missoula. To his knowledge, Ruby says that's the largest energy expenditure ever recorded by a human in a single day. Studying water turnover at the Badwater Ultramarathon, the 135-mile race from broiling Death Valley to Mt. Whitney, Ruby and his colleagues found that racers sweated and replaced nearly 90 percent of their bodies' liquid, on average. The figure, says Ruby, was far higher than anything yet documented by science using stable isotope tracers for that short of a time period.

His interest wasn't coldly academic: Ruby is a lifelong runner who walked onto his college track teams at Colorado State University and, after transferring, at Seattle Pacific University—running the 400 and 800 and 4 x 400 relay, and dabbling in the steeplechase and 400 hurdles. As he was casting about for a major, a friend cajoled him into taking an exercise physiology course. He was fascinated. The human body in motion was a churning, changing system that posed so many questions. *People are actually doing research on this stuff? This is crazy!* he recalled thinking. *This is the most dynamic way to learn I can think of: classroom it, then live it out on the track.* By age 26 he had a doctorate, a wife, and a job offer in Montana.

"What I first noticed about Brent is that he was so different," Ruby's wife, the blonde, bright-eyed Jo, says one evening in their kitchen as we eat her husband's "hippie pizza"—covered with a trainwreck of pesto, pomegranate seeds, venison sausage, another kind of sausage, and asparagus that's so odd it works. (Call it a savory metaphor.) The two met atop running shoes in college and have been married 25 years. "I think Brent is one of the few people who honestly enjoys his life. Few people can say that."

Two decades later it's clear that Ruby still hasn't lost his early awe at what the body can do. "Every human has that capacity to go huge, within reason."

Since that early work, Ruby's interests in performance have broadened, but much of his work is informed by his upbringing as the son of a minister who is an artist in his free time. (His father's father was a minister and artist, too.) His studies are often creative (e.g., the McDonald's-food study). They look at a problem differently. And frequently they contain what might be called a whiff of morality: Ruby wants the outcomes to help people, not sit on a library shelf.

In 2007, to test established ideas about overtraining, his team took the Airstream and a dozen young, fit cyclists on one of the more punishing science experiments devised: a 2,000-mile bike tour through

the Rockies. The subjects rode 100 miles a day, nearly every day, for 21 days. Ruby gave the young men time trials every three days and poked and prodded them throughout the journey. Even though they were hammered and the "traditional markers of overtraining" occasionally appeared in their saliva, their time-trial times were maintained or only grew faster as the study progressed. "We really could not overtrain them," Ruby told me. That doesn't mean overtraining doesn't happen, but it suggests that many of the signs athletes worry about "are simply markers of a necessary training stress," he said. If you're exhausted while training, the answer isn't necessarily to work out less vigorously, Ruby says, but to plan more recovery time, and to ask yourself whether lack of sleep, work stress, or other factors are what's really dragging you down.

ALL OUT
At work and play (here with his dog, Wrango), Ruby prefers to keep things light.

Yet the work that Ruby relishes most—work in the field, with real-world applications—is what sometimes causes him the most heartburn.

"That kind of research is a bitch to publish," he says. The academic world values "bench work," in which every variable is overseen, and is understandably wary of studies done in less-managed environments. "Previous concerns were addressed, but I still can't get over the fact that this wasn't done in a controlled laboratory environment," one anonymous reviewer wrote of the metabolic markers paper from Ruby's cycling study, which was rejected by two journals before finding a home. (Ruby's other paper from that study, about overtraining, was rejected once before making it into a journal.)

Ruby counters that WPEM does do top-notch work in the research center. Then the team steps outside.

"We are unapologetic in our quest to conduct research in tricky environments where all the free-range humans live, play, work, bonk, and try and keep from dying," Ruby says. "Without it, I don't think we can adequately solve real-world problems." He adds, "Nobody wins an Olympic medal on a cycling erg [machine]. Nobody fights a forest fire in an environmental chamber. You've got to get out there where it's nasty." One of his favorite books is *Don't Be Such a Scientist*, a manifesto for academics to engage society.

Wayne Williams is grateful for Ruby's approach. "One thing about academics is that they're not good about getting information down to my level," says Williams, a retired smoke jumper and currently a national fire safety officer who has worked with Ruby on several studies. Williams says he admires Ruby because he does the work and "then he's willing to come out in the field and teach us."

Meanwhile, Ruby continues to chase cool, counterintuitive ideas that have interesting applications. WPEM recently completed a yet-unpublished study that shakes up established notions about the benefits of altitude training. The team found that when test subjects exercised at elevations much higher than they were accustomed to, the postexercise gene expression that kick-starts changes in the muscles' mitochondria (the powerhouses of cells) "is severely diminished," he says. "You don't get much out of the work" muscle-wise, compared to working out at your "normal" elevation. "Is training at altitude or recovering at altitude beneficial to your performance? It mostly matters where your competition is going to occur," says Ruby. "If it is going to occur at sea level, then, no, I wouldn't waste my time."

One morning in Missoula during my rest period between rides in the junk-food study—I'd just polished off the first of two required McDonald's meals (not bad going down, but with a chaser of queasy regret)—Ruby and I sat on couches in WPEM and discussed his latest passion: protecting soldiers, firefighters, and athletes from the dangers of overheating. On a windowsill nearby sat a water bottle autographed by the ultrarunner Jurek, whom the crew roasted in Death Valley and their environmental chamber for an episode of The Weather Channel show *Freaks of Nature*, until they tripped the circuit breaker. (The withered Jurek was a good sport, Ruby reports.)

Research by Ruby's team recently suggested that skin temperature, not core body temperature (as was long thought), is a substantial factor in why performance craters in the heat. As we exercise, more blood rushes to the skin's surface to try to dissipate heat, the theory goes. Competition arises for limited blood supply. If the skin warms too much, the muscles lose out; you're dropped from the lead pack.

Now, Ruby said, "I really think one of the secrets of a sub-two-hour marathon is keeping skin temps down low." He shouted across the center to Cuddy, who'd been upstairs crunching numbers on a new skin-temperatures study. "Cuddy, what do you think the skin temp is for a sub-two-hour marathon?"

"Below 33" (centigrade), Cuddy guessed. "Around 30." That's 86°F.

There's a reason, Ruby said, that most distance records are set in cool weather.

The lesson for you and me? Stay strong, and keep really cool: Maximize the temperature difference between your core and your skin by wearing minimal clothing, or use sunscreen, or wear a white shirt. Based on their heat-stress work, Ruby and his team formed a company to create a wearable monitor—"imagine a heart-rate monitor on steroids," he says—that could tell the user, or a drill instructor at boot camp, or a football coach, whether the athletes are overheating.

"I have tons of things I want to look at. Some of them are pretty legit. Some of them are pretty goofy," Ruby says. Recently he helped bring to market a snack bar made largely of grass-fed Montana beef in flavors like mango curry. Omnibar is like Ruby in a wrapper, which is to say quirky, and a tweak on mainstream thinking. Instead of a highly engineered, carb-loaded bar that tastes like dessert, or plain old jerky, he asked, why not give people an in-between—a "dinner plate" bar made of whole foods like beef, plus grains and sweet potatoes, that can satisfy hunger on an all-day hike or a 50-mile run? He's been known to go for long runs carrying pencil and paper, to jot down ideas spurred during, and by, his own workouts.

Back in WPEM after my biopsy and McDonald's breakfast, I talk to Ruby about the study. He's interested in quick muscle recovery, the kind that lets a tired soldier or a hard-core athlete get up and push hard again that afternoon or the next morning. That sort of recovery is more complicated—yet also simpler—than nutrition-product makers would have you believe, Ruby says. Work in his lab has shown, for instance, that the environment in which your muscles recover plays as big a role in their refueling as what you eat after that 10-miler. Recently, his team teased out the ideal conditions for fastest recovery: Keep the body cool, but keep the exhausted muscles warm. That's nearly impossible, Ruby says.

Years of running wisdom are detonating around me. "Shouldn't I be drinking chocolate milk," I say, "while standing in a cold river?"

"—with compression socks on!" he giggles. "And with a magnetic bracelet!"

Make no mistake: Ruby isn't arguing that you should chase every run with fast food. But you could, in a pinch. The body often does great with what it's given.

"So what do you do after a hard workout?" I ask him.

"I never obsess about it, hardly ever," Ruby says. "And I *(continued on page TK)*

Food for thought

WPEM's researchers have done, or are tackling, many cool studies that can help make you a smarter—maybe even faster—runner. Here's a sampling

Skin Temperature

In a 2010 study, WPEM looked at recreational female runners at the Missoula Marathon and found that skin temperature and percentage of body fat, taken together, better indicated finish time than the classic fitness markers of VO_2 max and percentage of body fat.
THE TAKEAWAY: To maximize performance, keep your skin as cool as you realistically can—by wearing sunscreen, white clothing, shorts and T-shirt, etc. You often can wear less than you think while exercising.

Altitude Training

In a not-yet-published study, Ruby found that test subjects who exercised at elevations much higher than they were accustomed to didn't get the same postexercise gene expression in their muscles.
THE TAKEAWAY: Don't bother with altitude training unless you're going to race at altitude, opines Ruby. "You better move to Boulder because you really like Boulder."

Overtraining

Ruby and his team tested cyclists throughout a 21-day, 2,000-mile bike tour in the Rocky Mountains for markers that signal overtraining. Even though traditional markers of overtraining appeared, the cyclists' time-trial times were equal or grew faster as the tour progressed; they could not be trained too much.
THE TAKEAWAY: If you're fit but tired, instead of simply backing off on the intensity of your training, try giving yourself more recovery time, getting more sleep, or mitigating other factors like work or personal stresses.

Workout Environment

Ruby next wants to study whether training in varying environments affects the gene response—that is, if running a bit in the cold, and the heat, and at altitude, and some beside the beach, might make for ideal training.
THE TAKEAWAY: Ruby's hypothesis is that mixing it up makes the body stronger, just like the best way to train for a strong 10-K isn't to run a 10-K every day. "So the less you can provide the same old, same old, the better."

Slushy Hydration

WPEM is now studying whether drinking an ice slushy during exercise in very hot weather slows down the body's rise in temperature.
THE TAKEAWAY: If proven to work, a slushy could help a runner feel better and keep going—and could be offered alongside the water at aid stations at hot races. —C.S.

TK JUMP

Continued from page tktk

obey my cravings." He eats real food—some protein, some carbs. The occasional doughnut. He rarely touches the highly engineered stuff. "We've been eating food a lot longer than commercial, enhanced sports-nutrition products."

Two hours after my postcycling meal of McDonald's pancakes (no butter or syrup), hash browns, and orange juice, grad student Mike Cramer, who is running the study for his Master's thesis, sits me down to a hamburger, fries, and a soda. Two hours after that, Ruby skewers me once again to gauge how much glycogen the muscle has resynthesized, or rebuilt. Then I'm put atop the same stationary bike to grind out a 20-kilometer time-trial as fast as possible. It's a grim, panting 34 minutes and 47 seconds.

A week later I return to campus and do the same routine all over again, this time while fed the same macronutrients but in sport supplement items like Gatorade, energy cubes and Clif Kit's Organic Bars. That afternoon I pedal away on a second time trial. It doesn't feel any easier.

Weeks later Ruby shares my results: On my second ride, I finished four seconds slower than my time when fueled by McDonald's. Initial results showed that both diets produced similar time-trial results in the riders, says Ruby, though he cautioned that the study hadn't been finalized.

"I would like the take-home message to be that recovery foods come in all shapes and sizes, and they are often widely more accessible than a lot of these engineered sports supplements," Ruby told me.

How will the study be received? "I anticipate that there will be folks within the field who say, 'I hate that study. It sends the wrong message,'" he replies. "Well, then, you're reading it wrong."

Ruby the evangelist can't wait to take these results to the people—a speakers' series at the local grocery this spring, a running camp this summer. "I'll be bringing this up every chance I get," he says. "It's just the ultimate way to present what you need to take in, to recover adequately. The point being that muscle recovery isn't as complex as people think, and that sensible combinations of macronutrients from a wide range of possible sources can work as good or better than engineered products. Everyone understands McDonald's. And everyone thinks, *Ooh, do I dare?*"

And the good professor laughs. RW