

# Running Efficiency: It's Good, but How Do You Get It?

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IN her prime, Joan Benoit Samuelson, one of the best female distance runners, should have been faster than Alberto Salazar, one of the best male distance runners.



**FUNCTION** Alberto Salazar's style was less than classical, but effective. Ms. Samuelson's running was beautifully smooth. Mr. Salazar's was not.

"He looked terrible," said Jack Daniels, an exercise physiologist at the Center for High Altitude Training at Northern Arizona University, who studied both runners in the 1980's. "She looked great."

Not only that but Ms. Samuelson also had an amazing ability to use oxygen to fuel her body, Dr. Daniels said. Even though women's maximum oxygen consumption, or  $VO_2$  max, is typically lower than that of men, hers was as high as Mr. Salazar's. Maximum oxygen consumption was often considered one of the best predictors of performance in distance events.

But Mr. Salazar always ran faster than Ms. Samuelson. The difference between them turned out to be one of the least understood and most mythologized aspects of

performance: economy of motion. It's the relationship between how much energy you expend and how fast you go.

"How much is it costing you to run 10 miles an hour?" Dr. Daniels asked. "If it costs you less than it costs someone else, you are more economical."

Mr. Salazar, despite his less than classic running style, expended less energy when he ran. So when he and Ms. Samuelson put out the same effort, he ran faster.

Economy can make the difference between being fast and being slow, between winning and losing in swimming to skiing, cycling to speed skating, running to rowing.

But economy is baffling. It seems to be physiological, but it is not clear what exactly is involved. Is it an ability of muscles to use energy, an ability to use a variety of muscles in concert, an ability of nerves to activate certain muscles for a task while allowing other muscles to relax, an ability of nerves to fire in near-perfect patterns? Or is it all of these things in combination?

While many exercise physiologists believe, or hope, that economy improves with training, they confess that it's not clear what kind of training or how much it takes to make a difference.

They know that standard training programs, which emphasize speed and distance, improve the other key factors in performance: VO<sub>2</sub> max and the anaerobic, or lactate, threshold, an indicator of how intensely a person can exercise.

But economy is more of a mystery. In fact, there are only a few documented cases of athletes whose economy improved. One was Paula Radcliffe, the British marathoner. Every year for 11 years, starting in 1992, she increased her running economy by about 1 to 3 percent. In the end, she ran 40 seconds to a minute faster per mile, without changing how much oxygen she took in.

Then there was [Lance Armstrong](#), studied by Edward Coyle, an exercise physiologist at the [University of Texas](#), Austin. Over seven years from age 21 to 28, Mr. Armstrong gained about 1 percent a year in efficiency.

And there was Steve Scott, a runner who broke the American record for the mile in 1982. In just 18 weeks of intense training, he improved his running economy by 5 percent, said Gary S. Krahenbuhl, an exercise physiologist at [Arizona State University](#). Mr. Scott's improved economy allowed him to run faster than the previous mile record holder, Jim Ryun — the two runners were essentially equal in all other physiological measures, Dr. Krahenbuhl said.

But, Dr. Coyle said, "whether an average person running an hour a day would experience the same benefit is the million-dollar question."

Researchers are finding that easy assumptions about exercise economy just don't hold up under rigorous study.

Take the idea that you can tell who is an economical runner or cyclist by watching the person perform. Not true, researchers say. The only way to know is with tests in a lab.

Dr. Daniels showed this in a study in which he videotaped runners. Then he sent the videos to coaches and biomechanics experts, and asked which were the more economical runners.

“They couldn't tell, no way at all,” he said.

But can runners become more economical if they change their form? The surprising answer seems to be no, said Dr. Krahenbuhl. In fact, he said, every study that asked what happened after runners changed their natural form found that running economy declined.

It may take a long time for a change of form to result in better economy, Dr. Daniels suggested.

But it also may be that changing your form will never help you. Coaches often tell athletes to work on their form to become more economical, Dr. Daniels said. “But what they are really saying is, ‘We will work on your technique to make you look more like I think you should look,’” he added.

Maybe economical runners or cyclists or swimmers are simply gifted in general, researchers speculated. Perhaps whatever these athletes turn to, they will be economical.

That, Dr. Daniels discovered, is not true.

He recently studied runners and measured their economy when they ran. Then he measured it when they cycled, when they walked uphill at three different inclines on a treadmill, when they stepped up and down on a step, and when they cranked an ergometer with their arms. There was no relationship between being economical at one activity and being economical at another.

Still, there are a few tricks for novices, said Dr. Daniels. Most runners, he said, naturally fall into their most economical stride. But some bound along or, at the other extreme, take too many little steps. After studying hundreds of runners, Dr. Daniels discovered that taking 180 steps a minute made the most of energy expended.

Dr. Coyle finds that the most economical cyclists have an abundance of a particular type of muscle fiber, so-called slow twitch. It is not known whether other types of muscle can convert to slow twitch with training. But, he said, it may be that after years of training, nerves are directed to allow more leg muscles to participate in pedaling. The result might be greater riding economy.

“You might wind up changing the way your neuromuscular system is wired,” Dr. Coyle said. “It is a controversial area, but it makes sense.”

With swimmers, Dr. Coyle said, speed depends a great deal on technique, which can improve to a certain extent with coaching and training. Swimmers must overcome the drag of the water, and anything that interrupts the fluid dynamics of their motion will cause them to decelerate.

But physiological economy can also have a huge effect in swimming. Dr. Daniels studied a woman who won an Olympic gold medal even though her VO<sub>2</sub> max was only average for a recreational athlete and was very low for an elite athlete. Her gift? She wasted little energy, and that skill more than compensated.

No one has rigorously studied swimmers and documented that training improves economy. But exercise physiologists note that competitive swimmers practice for hours a day, even though their races last just minutes.

“Some physiologists say, ‘Look you don’t need to do that,’” Dr. Coyle said. “But the athletes think it is beneficial.” The reason, he suspects, is that all that training is needed to improve economy.

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