Can Our Bodies 'Learn' to Withstand Frigid Temperatures?

By: Allison Troutner | Feb 1, 2022

Many members of San Francisco's South End Rowing Club swim to Alcatraz and back regularly. Tony Gilbert (not pictured) has been swimming in the cold waters of the San Francisco Bay for 11 years. FREDERIC LARSON/SAN FRANCISCO CHRONICLE VIA GETTY IMAGES

It's a brisk morning at the sandy shore of San Francisco Bay. Goosebumps cover Tony Gilbert's body, bare except for his uniform of a pair of swim trunks, swim cap, earplugs and goggles. He wades into 46-degree Fahrenheit (7-degree Celsius) water and swims out into the murky bay. He returns to shore 40 minutes later, exhilarated.

Gilbert isn't a former Olympian swimmer. He's not part of a super-athlete team, though he knows swimmers like that. He's a hobby cold-water swimmer. For 11 years he's been doing it, and he's never looked back.

"It's really cold! But we wouldn't do it if it wasn't fun. It's invigorating really!" Gilbert says. "You're taking a bite out of life. The first few minutes are still the worst, then you get going, the endorphins kick in, and you love it."

Gilbert is one of the brave members of the South End Rowing Club, founded in 1873, who regularly take dips in the frigid bay — for fun. The waters, by the way, average around 56 degrees Fahrenheit (13 degrees Celsius).

These swims aren't a one-off of the polar plunge; they're regular events for the group. Gilbert's swims range from 20 to 40 minutes, but he swims as long as 90 minutes. Curious onlookers might wonder how he doesn't experience hypothermia, or why he enjoys swimming in such cold waters?

Turns out that the human body has evolved to take on some pretty helpful tools to acclimate to different kinds of cold stress. In fact, some of those acclimations to cold stress might even help prevent diseases like Type 2 diabetes.

Getting in the Habit of Being Cold

As we mentioned, our bodies have evolved to get used to cold temperatures when necessary. There are three ways our bodies cope with cold:

1. cold habituation: reduction in response to cold; higher skin temperatures
2. metabolic adaptations: creating heat by responses like shivering
3. insulative adaptations: conserving heat via things like fat layers

Habituation is the most common response to cold found in humans. This is what most of us experience any time we are out in the cold repeatedly because it doesn't have to be lengthy. We experience habituation even on a cold freezing morning, during a 10-minute dash to the local café for a cortado.

Habituations are like memorization. Instead of wasting valuable bodily energy sending up red flag neurons to your central nervous system every time your body is exposed to the same cold event, it remembers it and responds less. You won't shiver as much and your body gets used to the temp and keeps the skin on extremities, like our hands, warmer for longer.

That's why the more Gilbert swims, the longer his sessions can be, over time. Even after 11 years of swimming, though, it always takes a few minutes for him to get comfortable in the water, he says. "Of the hundreds of swims I've had, still to this day, the first few minutes in that cold water is the worst, and I have initial doubts. But you stay in, and you get used to it. Then after about five to 10 minutes, it's like a runner's high; you're euphoric."

"Getting used to it" is one way to describe that the body notices the stimuli — in this case cold temperature — isn't going away and adjusts.

Even the best, most adjusted swimmers get too cold and must stop when their body tells them it's time. "Your body keeps warm at the core, so your extremities can get cold, especially your fingers or toes," Gilbert explains. "On longer swims, you'll even see some people get a 'claw hand,' or some people get numb in the lips for a few minutes and slur their words when they get out of the water."

Vasoconstriction, another habituation mechanism, is what causes claw hands when blood supply is drawn away from the body's extremities to conserve heat. But a swimmer can't adjust to swimming long lengths in the cold waters of the bay on their first trip; it also requires a process of acclimation.

A quick polar plunge like this one in Chicago in the frigid waters of Lake Michigan doesn't require acclimation the way cold-water swimming like Gilbert does in the San Francisco Bay.
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Acclimation vs. Adaptation

Acclimation and adaptation are often used interchangeably; however, they're not the same. Acclimation is a slow, physiological change to the body that allows it to handle a different environment — in this case cold temperatures. Acclimation can take place over a few days, weeks or even months. Adaptation, however, is the genetic process by which an entire population must change to accommodate environmental factors. Adaption can take generations to develop.

After years of swimming in the Bay, Gilbert's body has acclimatized and now he can go on swims for more than an hour. If he had tried that on his first go, he could have died from hypothermia.

"You have to be regular, consistent with cold water swimming, to stay acclimated," Gilbert explains. A fellow swimmer who leads a clinic for beginners, got Gilbert hooked on cold swimming. "She said you have to swim two to three days a week to stay acclimated. And the few times I did have a break or fall off schedule, I would start back at square one, start with a short 10-minute swim one day, then the next day try 15, 20, and then back to 30 or 45 minutes," Gilbert says.

Acclimation happens when our body's core temperature is driven down for a prolonged period of time, repeatedly. That's when we see more long-term insulative adaptations (better blood flow, fat layers) that help our bodies conserve heat.

Within the recent decades, scientists have discovered that there's a very special kind of fat that is responsible for keeping our bodies warm, especially in repeated cold stress. Brown fat.

Brown Fat: The Fireplace in Your Body

Brown adipose tissue — aka brown fat or BAT — is the kind of fat that you want on your body because it helps maintain body temperature. Zhiqiang Lin, Ph.D. is an assistant professor at the Masonic Medical Research Institute (MMRI) in Utica, New York. The goal of the "Lin Lab" is to study the genetic programs that control brown fat growth and function.

"Brown fat refers to brown adipose tissue that consumes fatty acids for heat production," says Lin, who helped develop new technology for studying brown fat. "Compared to white fat (white adipose tissue), brown fat cells have more mitochondria and less lipid contents. Brown fat serves as a fireplace in our body to keep us warm."

Brown fat transfers energy from food into heat, which is why it plays an important part in keeping our bodies warm.

Some scientists argue that brown fat evolved early on in mammals, and helped give us a leg up from other species. Human babies are born with a lot of brown fat, to protect them from cold at birth, but it's cold stress that builds up BAT in adults.

"Regular cold stress may increase innervation in brown fat and skeletal muscles," Lin explains. "Therefore, individuals regularly exposed to cold (such as winter swimmers) have higher heat generation efficiency than normal healthy individuals."

Not only does brown fat help keep people exposed to cold stress warmer, but recent studies also suggest it plays a role in maintaining our metabolic homeostasis, which can protect us from metabolic diseases, like Type 2 diabetes, obesity and cardiovascular diseases, Lin explains.

"During cold exposure, nerves under the skin transduce a cold signal to the brain, which then sends out signals to brown fat or skeletal muscle to generate heat," he says. "Therefore, regular cold exposure potentially increases calorie consumption and may be beneficial for preventing obesity."

Studies have shown that people who are exposed to cold temperatures regularly — also known as cold stress — may have more 'brown fat,' which plays an important role in keeping our bodies warm.
ALEX RATSON/GETTY IMAGES

Do We Inherit Cold Adaptations?

Indigenous peoples who are acclimatized to cold environments typically show adaptations that keep their bodies warmer longer, according to studies on human adaptations to cold stress.

In studies of the Inuit peoples of the Arctic and Norwegian Lapps, the types of responses they experienced due to whole-body cold stress were the same as people in warmer climates. If it gets really cold, they'll shiver, for example, but their responses were less pronounced. Meaning that it could get a lot colder before they would start to experience the same responses that we get walking from our car to our office in freezing temperatures.

On average, their skin was warmer, their blood flow to their extremities was greater, so they lost less heat from their hands. However, when the study looked at children of those groups, they were not as acclimated to the cold stress as adults.

The study suggested that cold acclimation was not inherited, but rather a result of exposure over time. Other studies have shown that there are genetic factors to cold adaptations, too. Recent studies have found that groups indigenous to cold climates have genetic markers that are involved in active BAT.

While many mechanisms are similar to groups not exposed to cold stress, there may be genetic aspects at play for groups or individuals, too.

Does Being Cold Make Us Healthier?

For most of us in modern society, we experience cold habituation not complete acclimation because we change our behaviors by wearing more clothes, living in heated houses, driving heated cars and working in warm offices. But research topics like Lin's brown fat studies on metabolic disease, and research into the health benefits of cold exposure like cold water plunges or cold showers, are proving that adaptations to cold can improve our health when done safely.

And Gilbert, though he isn't a scientist, knows that the nippy waters of the Bay offer an experience unlike any other. "Cold water swimming feels like you're taking a bite out of life! There's nothing else like it," Gilbert says.

Now That's Crazy

Honorary South End Rowing Club member, Lynne Cox, is the first person to swim the frozen waters of the Antarctic Ocean without a wetsuit. Her swim, which lasted more than 30 minutes, was in 32-degree Fahrenheit (0-degree Celsius) water and went on for 1.2 miles (1.9 kilometers). She is one of only two people on record in the world known to survive that kind of cold.

Games