USAF photo by SSgt. Christopher Boitz

What It Takes

By Elise Steinberger

A pilot flies an aggressor mission during Red Flag-Alaska in 2009. Flying a fighter jet can take a toll on pilots' physical condition. They must stay in tip-top shape.

Physiologically, being a fighter pilot does not come naturally.

Few would argue that the human body is "built" for high-performance flight. Substantial physical and cognitive challenges routinely tax pilots' bodies, including the need to fuel a working brain with the oxygen it needs—an easy task on the ground, not so much while experiencing the G-forces in a modern fighter cockpit.

Developing inherent physical characteristics and cognitive capabilities through years of training builds pilots who can operate with extraordinary precision and accuracy.

"We need the person who ... has those health standards to withstand that environment, that cognitive capacity to engage in that environment, and that optimized physical conditioning to endure that environment—and it's pretty impressive the folks ... our country has been able to put out," said Dr. James McEachen, an aerospace medicine physician and researcher at the Air Force Research Laboratory, Wright-Patterson AFB, Ohio.

In a modern day fighter aircraft, pilots defy gravity in more than one way. The force of gravity the aircraft overcomes to leave the ground almost pales in comparison to G-forces a pilot's body and mind cope with while trying to function normally while flying.

"If you're trying to fly defensively, for example, put on six layers of clothes, strap yourself into your [aircraft], lean forward, turn around, put a helmet on your head, and then have an elephant sit on you," said Lt. Col. Courtney A. Hamilton, an F-15C pilot and commander of the 12th Operations Support Squadron at JBSA-Randolph, Texas.

ANATOMY LESSON

The human heart is used to battling Earth's gravity as it pumps blood to move oxygen to the brain, while muscles in the lower body help return the blood to the heart. However, when pilots experience positive Gs it's as if gravity is on steroids.

"At nine Gs that column of blood [between the heart and the eyes] weighs nine times the weight that it does for somebody who's just sitting at their chair at their desk. It makes it very difficult for the heart to pump that blood up back to the head," said Lloyd D. Tripp Jr., program manager at Wright-Patterson's 711th Human Performance Wing Human Effectiveness Directorate.

This makes delivering oxygen to the brain a unique challenge, but anti-G strain maneuvers and anti-G suits make it possible for pilots to somewhat regulate where the blood in their body goes.

"You're working pretty much every muscle in your body, from your rib cage down," said Maj. Willem Van Loon, a T-38 instructor pilot with the 560th Flying Training Squadron at Randolph.

Pilots tense lower body muscles to help return this "heavy" blood back to their hearts, while their anti-G suits help move the blood as well, said Tripp. Moving blood from the heart to the head is a coordinated effort between muscle contraction and breathing regulation, through the anti-G straining maneuver.

"You take that breath in and then you hold it for about two to three seconds. When you do that, you increase the pressure in your chest and that increases the pressure in the heart, which aids in increasing the head-blood pressure as well," Tripp said.

All this makes the heart able to squeeze blood into the head against the strong downward force of Gs. Delivering this oxygen to the brain is necessary to main-

tain vision and consciousness—among other things.

Lt. Col. David Leazer, an F-16 pilot and 12th Operations Group deputy commander at Randolph, said that without employing these skills, the body's ability to tolerate Gs drops off sharply. "The more Gs you pull, the faster the blood will leave your brain. ... When you start getting up to the six, seven G range, now you're talking about having 10 seconds of useful consciousness if you're not doing [the anti-G straining maneuver]. ... When you're up in the eight to nine G range you're probably talking two to three seconds of useful consciousness, if you don't strain at all."

Using the straining maneuver while flying is crucial, as is exercising regularly and hydrating well.

"If you're a quart to a quart-and-a-half low with fluid intake, that can reduce your G tolerance by up to about 50 percent, leaving a pilot susceptible to a G-induced loss of consciousness [G-LOC] episode," said Darryn Bryant, a research aerospace physiologist at the Air Force Research Laboratory.

Along with G-forces, high altitude further complicates oxygen delivery to the brain when oxygen in the cockpit might be low.

Bruce Wright, senior research physiologist at the USAF School of Aerospace Medicine at Wright-Patterson, said slow-onset hypoxia—a lack of oxygen different from the rapid oxygen deprivation in the brain caused by G-forces—negatively affects cognitive function to varying degrees in different people. In a controlled environment on the ground, pilots learn to recognize their symptoms, such as dizziness or tunnel vision, to know when to use supplemental oxygen, he said.

"What in effect you're doing is you are asking an impaired person to detect how impaired they are," said Wright, adding that this pushes researchers to find other ways of detecting whether a pilot is becoming hypoxic.

Moving oxygen to the brain is just one of the physical hurdles that comes with high-performance flight, but as the mental and physical pressures on the pilot are intertwined, fueling the brain is essential for optimal performance.

"You combine that physical demand with a need to multitask at a very fast rate— ... it feels like you're trying to solve math problems while doing a CrossFit exercise," Leazer said, referring to a high-intensity strength and conditioning program. However, it becomes easier with time. "The longer that you do it, experience takes over, muscle memory takes over. So when you're just starting out, the hardest part is getting used to the physical endurance required and then building in the multitasking piece."

Maj. Gentry Mobley, Air Education and Training Command's fighter training branch chief, said a building block approach during training makes it possible for pilots to keep adding new tasks, like the G strain, because they become second nature.

MULTITASKING

Through training and repetition, G-strain becomes second nature, and an experienced pilot will skillfully manage large amounts of information and new tasks. "If I were leading an eight-ship of Eagles in front of a 40-ship strike package, I'm keeping track of my eight airplanes, where the other 40 strikers are, where's the tanker, where's the AWACS, where's the bad guys, who's going after which bad guy, how much gas do I have, how much gas does my wingman have, how many missiles do we have, how many shots have we taken, do we need to turn around now, do we need to go over there, how's the weather, are we on time, ... and I still have to fly my plane ... and deal with all the physical parts," said Hamilton, the 12th OSS commander.

Maj. Dorian Williams, aerospace physiology aircrew curriculum manager at AETC, added that as pilots learn, they use less "conscious input and brain bytes" on habitual tasks.

Capt. Christopher Umphres, a flight commander in the 435th FTS at Randolph, said simulators are valuable tools for learning how to quickly and effectively process information when flying. Van Loon said thinking through scenarios on the ground also speeds up decision-making in the air.

"Put yourself in that situation and think about what you would do, so that next time when it happens in the air and you're at 400 mph and you have four seconds to make the decision, you already kind of know, 'Ah, I remember thinking about this before,'" said Van Loon.

Even when pilots manage certain tasks subconsciously, knowing where and when to focus mental attention is critical to success.

"What that involves is having the ability to prioritize where you focus your attention and then to take the right sequence of actions, very deliberately, and do it in a time sensitive matter," said Lt. Gen. Mark A. Ediger, Air Force surgeon general.

Selection, training, and human systems integration—tailoring weapons systems to make them optimal for the physical and cognitive capabilities of humans—are instrumental in producing successful fighter pilots, said Ediger.

Flying fighter aircraft requires high levels of cognitive function, especially in areas of spatial functioning, reasoning, processing speed, and calculation, said Wayne L. Chappelle, a consultant in aeromedical clinical psychology in the Office of the Air Force Surgeon General at the USAF School of Aerospace Medicine.

Fighter pilots score in the 90th to 94th percentile for IQ in the general population, landing them in a "superior range of functioning," Chappelle said. Along with this cognitive functioning, fighter pilots are high on the axes for two other broad categories: stability and motivation. He said stability includes less autonomic reactivity, such as elevated heart rate, increased blood pressure, and sweating, in difficult situations.

"These are individuals that have a high level of stress tolerance and what we would [term] resilience to demanding conditions. In other words, they can remain calm and composed in very high-risk, high-demand situations," Chappelle said.

Hamilton noted that mental compartmentalization is a key tool to keeping her mind clear and focused on the task at hand.

"When I get in the jet, that's all I'm thinking about," she said. "Everyone has stressors in their life. Everyone has something at home and something else at work, ... but I have to ignore that."

Whether flying or on the ground, pilots must embrace the idea that there is always more studying and more practice that can be done—physically and mentally, said Van Loon.

"You want to be on that razor's edge of 99 percent perfect every time you go, because it means life or death for you or somebody close to you," he said. This, and the security of the United States, motivates pilots to strive to be better every day. "That's the cost of doing business. That's what it takes." ✪