Before the morning of Sept. 11, 2001, when two airplanes crashed into New York City’s Twin Towers, William "Scott" Killgore knew little if anything about the science of sleep. Two decades later, he knows much more — specifically, how sleep affects human behavior, performance and well-being.

Killgore is the director of the Social, Cognitive and Affective Neuroscience Lab, known as the SCAN lab, in the UA Department of Psychiatry. Trained as a clinical neuropsychologist and research neuroscientist, Killgore researches the parts of the brain involved in emotional processes and cognitive performance. For the past decade, his work has focused on the mental health, well-being and performance of military personnel and combat veterans. His research is funded by the U.S. Department of Defense with the goal of trying to help people recover from traumatic injuries or traumatic stress.

Lo Que Pasa talked with Killgore, a professor in the Department of Psychiatry, about how sleep affects emotions, reasoning and decision making — and how caffeine can only go so far to make up for lack of sleep, a far too common condition.

You started your career studying adolescents and emotional regulation. What made you start studying sleep?

It was an accident. I was at Harvard doing research for my postdoc, and I was studying adolescents and emotional regulation. And then the Sept. 11 attacks happened. Afterwards, I talked with my wife and told her I felt a calling to go into the military. So, I applied to the Army to become a researcher, and they brought me in as an Army research psychologist at the Walter Reed Army Institute of Research. The lab I was assigned to was doing sleep deprivation research. I didn't know anything about sleep, but I learned. At first, I wasn't all that excited about the topic of sleep and sleep deprivation, but then I decided to combine my background in emotion and executive function research and applied it to studying the effects of sleep deprivation. That opened a whole new direction of research that had been virtually unexplored before. I was suddenly fascinated to investigate how lack of sleep affected emotional processing, judgment and decision making. Since then, it has become a rapidly growing area of research.

You say that emotions affect sleep, and sleep affects emotions. What do you mean by that?

The classic way that psychiatry has looked at sleep is that your emotional problems are impairing your sleep. For example, when people have a psychiatric disturbance, such as depression or bipolar disorder, that leads them to have altered levels of arousal and brain functioning, and they can't sleep very well. It was generally assumed that the psychiatric
condition led to bad sleep. We take it from the other direction; that is, getting adequate sleep is allowing your emotional circuitry to function normally. So, lack of sleep is altering the normal way that the brain works and can lead to dysfunctional emotional or cognitive functioning.

A lot of our work was built on a study that was conducted at Walter Reed years ago using PET, or positron emission tomography, a type of imaging. That research showed that when people are sleep deprived for 24 hours, the front part of their brain shows a decrease in metabolic activity, so they're essentially not "firing on all cylinders." The prefrontal cortex is the part of your brain that's involved in higher-level decision making, judgment and risk assessment. It regulates your emotions. It also seems to be one of the regions that is most affected when you're sleep deprived. It does most of the things that make us distinctly human.

You also found that sleep deprivation did not necessarily lead to deficits in executive function? that is, self-regulation and the ability to plan. How do you explain that?

This was an unexpected and inconsistent finding. People seem to differ in their ability to resist the effects of sleep loss. Sometimes people can go a night or two without sleep, and they seem okay, which is surprising. So, how are they doing that? I came to the understanding that there are different sections in the prefrontal cortex, which are involved in very different aspects of higher-level cognition. For instance, the dorsolateral prefrontal cortex, which is essentially the top portion, controls what we might call "cool" executive functions? that is, those kinds of cognitions that don't involve emotional reasoning. Interestingly, those areas seem to be pretty resistant to sleep loss in many cases. It looks like other areas of the brain can step in and act almost like a crutch and sustain many of these nonemotional executive functions.

But it's the bottom surface of the prefrontal cortex that plays the biggest part in regulating how you're feeling and how you respond to those feelings. We call these "hot" executive functions. This part of the brain learns from the rewards and punishments of past experience. That system also seems to be sensitive to sleep loss, changing your mood, changing the way you respond to emotionally salient stimuli or events. Most of the time you're not thinking about your mood or emotional status; it's operating down below the surface of conscious awareness, affecting your decisions and judgments. And as you go through life, you sometimes make poor decisions that don't make rational sense because you're lacking sleep. With lack of sleep, the amygdala, the brain's emotional engine, becomes poorly regulated by the prefrontal cortex. The prefrontal cortex normally puts the brakes on your amygdala, but now that you're sleep deprived, these two brain systems are not well-connected. In fact, we found that people who are sleep deprived make emotional decisions that are very similar to the decisions of people who have brain damage in a specific area of the prefrontal cortex. You can make a lot of bad decisions in life when they are made without sufficient sleep.

How about coffee? Does a cup of coffee or two help make up for sleep deprivation?

Back in the Army, we looked at the effects of sleep deprivation on cognition. Could we restore cognition with caffeine? For simple alertness and vigilance, caffeine helps during the first night,. But after about two nights, it's not so helpful anymore. We did a lot of work on the effectiveness of stimulants for restoring other aspects of cognition too. The cool thing that came out of those studies was that you can take the stimulants, and they'll wake you up, but people still have a pattern of behavior, particularly judgment and decision making, that looks a bit like they're brain damaged. Caffeine doesn't seem to restore that. So, you're not making good decisions, but you feel awake, so it can fool you into thinking that you're fine. But you're
making decisions just as badly as a sleep-deprived person without any caffeine.

You run a large, busy lab and have a personal life. But you look rested. How do you do it? What's your secret?

Consistency is one of the keys. I go to sleep close to the same time every day and wake up at about the same time every day, seven days a week. First thing in the morning, my wife and I have our coffee outside on the patio and get exposed to the morning sunlight. At night, we keep the bedroom dark, cool and quiet. I also use a light therapy device in the morning for about 30 minutes after I get to work. Your alertness and performance everyday are affected by light. Bright light does at least two things. It resets the circadian rhythm, and we think it activates systems in the brain that keep you alert. But just sitting outside, going out under the sunny sky, will temporarily make you feel more alert than you would otherwise. We have even shown that exposure to light after learning something new can help you to remember it better later.

Is there anything else we should know about sleep?

Get more of it. Nearly everybody needs more sleep. People typically don't get the seven to eight hours of sleep that most experts agree is optimal. Although there is a wide range, people in the U.S. typically get maybe six hours or less on average during weekdays and try to catch up on weekends. But playing catch up doesn't really work? you still carry a bit of a "sleep debt" that takes quite a bit longer to pay off. Most people do best with at least seven hours of sleep on a regular basis. So, most of us are not routinely getting enough, and it's affecting the way we respond to one another socially and emotionally. Nearly everything is harder when you haven't had enough sleep.

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