

Sleep Deficit: The Performance Killer

Sleep is a stranger to many managers. Research by leading scientists shows just how dangerous that problem is.

A Conversation with Charles A. Czeisler

Charles A. Czeisler and Bronwyn Fryer

At 12:30 AM on June 10, 2002, Israel Lane Joubert and his family of seven set out for a long drive home following a family reunion in Beaumont, Texas. Joubert, who had hoped to reach home in faraway Fort Worth in time to get to work by 8 AM, fell asleep at the wheel, plowing the family's Chevy Suburban into the rear of a parked 18-wheeler. He survived, but his wife and five of his six children were killed.

The Joubert tragedy underscores a problem of epidemic proportions among workers who get too little sleep. In the past five years, driver fatigue has accounted for more than 1.35 million automobile accidents in the United States alone, according to the National Highway Traffic Safety Administration. The general effect of sleep deprivation on cognitive performance is well-known: Stay awake longer than 18 consecutive hours, and your reaction speed, short-term and long-term memory, ability to focus, decision-making capacity, math processing, cognitive speed, and spatial orientation all start to suffer. Cut sleep back to five or six hours a night for several days in a row, and the accumulated sleep deficit magnifies these negative effects. (Sleep deprivation is implicated in all kinds of physical maladies, too, from high blood pressure to obesity.)

Nevertheless, frenzied corporate cultures still confuse sleeplessness with vitality and high performance. An ambitious manager logs 80-hour work weeks, surviving on five or six hours of sleep a night and eight cups of coffee (the world's second-most widely sold commodity, after oil) a day. A Wall Street trader goes to bed at 11 or midnight and wakes to his BlackBerry buzz at 2:30 AM to track opening activity on the DAX. A road warrior lives out of a suitcase while traveling to Tokyo, St. Louis, Miami, and Zurich, conducting business in a cloud of caffeinated jet lag. A negotiator takes a red-eye flight, hops into a rental car, and zooms through an unfamiliar city to make a delicate M&A meeting at 8 in the morning.

People like this put themselves, their teams, their companies, and the general public in serious jeopardy, says Dr. Charles A. Czeisler, the Baldino Professor of Sleep Medicine at Harvard Medical School.¹ To him, encouraging a culture of sleepless machismo is worse than nonsensical; it is downright dangerous, and the antithesis of intelligent management. He notes that while corporations have all kinds of policies designed to prevent employee endangerment—rules against workplace smoking, drinking, drugs, sexual harassment, and so on—they

sometimes push employees to the brink of self-destruction. Being “on” pretty much around the clock induces a level of impairment every bit as risky as intoxication.

As one of the world’s leading authorities on human sleep cycles and the biology of sleep and wakefulness, Dr. Czeisler understands the physiological bases of the sleep imperative better than almost anyone. His message to corporate leaders is simple: If you want to raise performance—both your own and your organization’s—you need to pay attention to this fundamental biological issue. In this edited interview with senior editor Bronwyn Fryer, Czeisler observes that top executives now have a critical responsibility to take sleeplessness seriously.

What does the most recent research tell us about the physiology of sleep and cognitive performance?

Four major sleep-related factors affect our cognitive performance. The kinds of work and travel schedules required of business executives today pose a severe challenge to their ability to function well, given each of these factors.

The first has to do with the homeostatic drive for sleep at night, determined largely by the number of consecutive hours that we’ve been awake. Throughout the waking day, human beings build up a stronger and stronger drive for sleep. Most of us think we’re in control of sleep—that we choose when to go to sleep and when to wake up. The fact is that when we are drowsy, the brain can seize control involuntarily. When the homeostatic pressure to sleep becomes high enough, a couple thousand neurons in the brain’s “sleep switch” ignite, as discovered by Dr. Clif Saper at Harvard Medical School. Once that happens, sleep seizes the brain like a pilot grabbing the controls. If you’re behind the wheel of a car at the time, it takes just three or four seconds to be off the road.

The second major factor that determines our ability to sustain attention and maintain peak cognitive performance has to do with the total amount of sleep you manage to get over several days. If you get at least eight hours of sleep a night, your level of alertness should remain stable throughout the day, but if you have a sleep disorder or get less than that for several days, you start building a sleep deficit that makes it more difficult for the brain to function. Executives I’ve observed tend to burn the candle at both ends, with 7 AM breakfast meetings and dinners that run late, for days and days. Most people can’t get to sleep without some wind-down time, even if they are very tired, so these executives may not doze off until 2 in the morning. If they average four hours of sleep a night for four or five days, they develop the same level of cognitive impairment as if they’d been awake for 24 hours—equivalent to legal drunkenness. Within ten days, the level of impairment is the same as you’d have going 48 hours without sleep. This greatly lengthens reaction time, impedes judgment, and interferes with problem solving. In such a state of sleep deprivation, a single beer can have the same impact on our ability to sustain performance as a whole six-pack can have on someone who’s well rested.

The third factor has to do with circadian phase—the time of day in the human body that says “it’s midnight” or “it’s dawn.” A neurological timing device called the “circadian pacemaker” works alongside but, paradoxically, in opposition to the homeostatic drive for sleep. This circadian pacemaker sends out its strongest drive for sleep just before we habitually wake up, and its strongest drive for waking one to three hours before we usually go to bed, just when the

homeostatic drive for sleep is peaking. We don't know why it's set up this way, but we can speculate that it has to do with the fact that, unlike other animals, we don't take frequent catnaps throughout the day. The circadian pacemaker may help us to focus on that big project by enabling us to stay awake throughout the day in one long interval and by allowing us to consolidate sleep into one long interval at night.

In the midafternoon, when we've already built up substantial homeostatic sleep drive, the circadian system has not yet come to the rescue. That's typically the time when people are tempted to take a nap or head for the closest Starbucks or soda machine. The caffeine in the coffee temporarily blocks receptors in the brain that regulate sleep drive. Thereafter, the circadian pacemaker sends out a stronger and stronger drive for waking as the day progresses. Provided you're keeping a regular schedule, the rise in the sleep-facilitating hormone melatonin will then quiet the circadian pacemaker one to two hours before your habitual bedtime, enabling the homeostatic sleep drive to take over and allow you to get to sleep. As the homeostatic drive dissipates midway through the sleep episode, the circadian drive for sleep increases toward morning, maintaining our ability to obtain a full night of sleep. After our usual wake time, the levels of melatonin begin to decline. Normally, the two mutually opposing processes work well together, sustaining alertness throughout the day and promoting a solid night of sleep.

The fourth factor affecting performance has to do with what's called "sleep inertia," the grogginess most people experience when they first wake up. Just like a car engine, the brain needs time to "warm up" when you awaken. The part of your brain responsible for memory consolidation doesn't function well for five to 20 minutes after you wake up and doesn't reach its peak efficiency for a couple of hours. But if you sleep on the airplane and the flight attendant wakes you up suddenly upon landing, you may find yourself at the customs station before you realize you've left your laptop and your passport behind. There is a transitional period between the time you wake up and the time your brain becomes fully functional. This is why you never want to make an important decision as soon as you are suddenly awakened—ask any nurse who's had to awaken a physician at night about a patient.

Most top executives are over 40. Isn't it true that sleeping also becomes more difficult with age?

Yes, that's true. When we're past the age of 40, sleep is much more fragmented than when we're younger. We are more easily awakened by disturbances such as noise from the external environment and from our own increasing aches and pains. Another thing that increases with age is the risk of sleep disorders such as restless legs syndrome, insomnia, and sleep apnea—the cessation of breathing during sleep, which can occur when the airway collapses many times per hour and shuts off the flow of oxygen to the heart and brain, leading to many brief awakenings.

Many people gain weight as they age, too. Interestingly, chronic sleep restriction increases levels of appetite and stress hormones; it also reduces one's ability to metabolize glucose and increases the production of the hormone ghrelin, which makes people crave carbohydrates and sugars, so they get heavier, which in turn raises the risk of sleep apnea, creating a vicious cycle. Some researchers speculate that the epidemic of obesity in the U.S. and elsewhere may be related to chronic sleep loss. Moreover, sleep-disordered breathing increases the risk of high blood pressure and heart disease due to the strain of starving the heart of

oxygen many times per hour throughout the night.

As we age, the circadian window during which we maintain consolidated sleep also narrows. That's why airline travel across time zones can be so brutal as we get older. Attempting to sleep at an adverse circadian phase—that is, during our biological daytime—becomes much more difficult. Thus, if you take a 7 PM flight from New York to London, you typically land about midnight in your home time zone, when the homeostatic drive for sleep is very strong, but the local time is 5 AM. Exposure to daylight—the principal circadian synchronizer—at this time shifts you toward Hawaiian time rather than toward London time. In this circumstance, the worst possible thing you can do is rent a car and drive to a meeting where you have to impress people with your mental acuity at the equivalent of 3 or 4 in the morning. You might not even make the meeting, because you very easily could wrap your car around a tree. Fourteen or 15 hours later, if you're trying to go to bed at 11 PM in the local time zone, you'll have a more difficult time maintaining a consolidated night's sleep.

So sleep deprivation, in your opinion, is a far more serious issue than most executives think it is.

Yes, indeed. Putting yourself or others at risk while driving or working at an impaired level is bad enough; expecting your employees to do the same is just irresponsible. It amazes me that contemporary work and social culture glorifies sleeplessness in the way we once glorified people who could hold their liquor. We now know that 24 hours without sleep or a week of sleeping four or five hours a night induces an impairment equivalent to a blood alcohol level of .1%. We would never say, "This person is a great worker! He's drunk all the time!" yet we continue to celebrate people who sacrifice sleep. The analogy to drunkenness is real because, like a drunk, a person who is sleep deprived has no idea how functionally impaired he or she truly is. Moreover, their efficiency at work will suffer substantially, contributing to the phenomenon of "presenteeism," which, as HBR has noted, exacts a large economic toll on business. [See Paul Hemp's article "Presenteeism: At Work—But Out of It," HBR October 2004.]

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Sleep deprivation is not just an individual health hazard; it's a public one. Consider the risk of occupational injury and driver fatigue. In a study our research team conducted of hospital interns who had been scheduled to work for at least 24 consecutive hours, we found that their odds of stabbing themselves with a needle or scalpel increased 61%, their risk of crashing a motor vehicle increased 168%, and their risk of a near miss increased 460%. In the U.S., drowsy drivers are responsible for a fifth of all motor vehicle accidents and some 8,000 deaths annually. It is estimated that 80,000 drivers fall asleep at the wheel every day, 10% of them run off the road, and every two minutes, one of them crashes. Countless innocent people are hurt. There's now a vehicular homicide law in New Jersey (and some pending in other states) that includes driving without sleep for more than 24 hours in its definition of recklessness. There's a man in Florida who's serving a 15-year prison term for vehicular homicide—he'd been awake for 30-some hours when he crashed his company's truck into a group of cars waiting for a light to change, killing three people. I would not want to be the CEO of the company bearing responsibility for those preventable deaths.

Sleep deprivation among employees poses other kinds of risks to companies as well. With too little sleep, people do things that no CEO in his or her right mind would allow. All over the world, people are running heavy and dangerous machinery or guarding secure sites and buildings while they're exhausted. Otherwise intelligent, well-mannered managers do all kinds of things they'd never do if they were rested—they may get angry at employees, make unsound decisions that affect the future of their companies, and give muddled presentations before their colleagues, customers, the press, or shareholders.

What should companies be doing to address the sleep problem?

People in executive positions should set behavioral expectations and develop corporate sleep policies, just as they already have concerning behaviors like smoking or sexual harassment. It's important to have a policy limiting scheduled work—ideally to no more than 12 hours a day, and exceptionally to no more than 16 consecutive hours. At least 11 consecutive hours of rest should be provided every 24 hours. Furthermore, employees should not be scheduled to work more than 60 hours a week and not be permitted to work more than 80 hours a week. When working at night or on extended shifts, employees should not be scheduled to work more than four or five consecutive days, and certainly no more than six consecutive days. People need at least one day off a week, and ideally two in a row, in order to avoid building up a sleep deficit.

Now, managers will often rationalize overscheduling employees. I hear them say that if their employees aren't working, they will be out partying and not sleeping anyway. That may be true for some irresponsible individuals, but it doesn't justify scheduling employees to work a hundred hours a week so that they can't possibly get an adequate amount of sleep. Of course, some circumstances may arise in which you need someone to remain at work for more than 16 consecutive hours. The night security guard, for example, can't just walk off the job if his replacement isn't there, so you will need to have a provision for exceptional circumstances, such as offering transportation home for a sleep-deprived worker.

Companies also need executive policies. For example, I would advise executives to avoid taking red-eye flights, which severely disrupt sleep. If someone must travel overnight internationally, the policy should allow the executive to take at least a day to adapt to the sleep deprivation associated with the flight and the new time zone before driving or conducting business. Such a policy requires some good schedule planning, but the time spent making the adjustments will be worth it, for the traveler will be more functional before going into that important meeting. And the sleep policy should not permit anyone, under any circumstances, to take an overnight flight and then drive to a business meeting somewhere—period. He or she should at least be provided a taxi, car service, or shuttle.

A company's sleep policy should not permit anyone, under any circumstances, to take an overnight flight and then drive to a business meeting somewhere—period.

Companies can do other things to promote healthy sleep practices among employees. Educational programs about sleep, health, and safety should be mandatory. Employees should learn to set aside an adequate amount of time for sleep each night and to keep their bedrooms dark and quiet and free of all electronic devices—televisions, BlackBerries, and so on. They should learn about the ways alcohol and caffeine interfere with sleep. When someone is sleep

deprived, drinking alcohol only makes things worse, further eroding performance and increasing the propensity to fall asleep while also interfering with the ability to stay asleep. Additionally, companies should provide annual screening for sleep disorders in order to identify those who might be at risk. For example, this past year our team launched a Web-based screening survey that any law enforcement officer in the U.S. can take to help identify whether he or she is suffering from sleep apnea, restless legs syndrome, narcolepsy, or other sleep disorders. Those whose answers place them at high risk are referred for evaluation and treatment by a specialist accredited by the American Academy of Sleep Medicine. [Accredited sleep centers may be found at www.sleepcenters.org.]

Finally, I would recommend that supervisors undergo training in sleep and fatigue management and that they promote good sleep behavior. People should learn to treat sleep as a serious matter. Both the company and the employees bear a shared responsibility to ensure that everyone comes to work well rested.

This corporate sleep policy of yours sounds a little draconian, if not impossible, given people's crazy schedules.

I don't think it's draconian at all. Business travelers expect that their pilots won't drink before flying an airplane, and all of us expect that no driver on the highway will have a blood alcohol level above the legal limit. Many executives already realize that the immediate effect of sleep loss on individuals and on overall corporate performance is just as important. A good sleep policy is smart business strategy. People think they're saving time and being more productive by not sleeping, but in fact they are cutting their productivity drastically. Someone who has adequate sleep doesn't nod off in an important meeting with a customer. She can pay attention to her task for longer periods of time and bring her whole intelligence and creativity to bear on the project at hand.

What do you think about the use of drugs that help people fall asleep or that shut off the urge to sleep?

These agents should be used only after a thorough evaluation of the causes of insomnia or excessive daytime sleepiness. Patients too often think there's a silver bullet for a problem like insomnia, and doctors too easily prescribe pills as part of a knee-jerk reaction to patient requests during the final minutes of an office visit. The causes of insomnia are subtle and need to be carefully investigated. These can be from too much caffeine, an irregular schedule, anxiety or depression, physical problems such as arthritis, use of other medications, and so on—and only a careful evaluation by a doctor experienced in sleep medicine can uncover the causes. I once saw a professor who complained of difficulty sleeping at night, and only after taking a careful history did we find that he was drinking 20 cups of coffee a day. He didn't even realize he was drinking that much and didn't think about the fact that so much caffeine, which has a six- to nine-hour half-life, would interfere with his ability to sleep. Prescribing a sleeping pill for his insomnia without identifying the underlying cause would have been a mistake.

There are non-pharmacological treatments for insomnia that seem very promising, by the way. Cognitive behavioral therapy, or CBT, helps people recognize and change thoughts and behaviors that might be keeping them awake at night. A researcher named Dr. Gregg Jacobs at Harvard Medical School has reported that CBT works better over both the short and the long term than sleeping pills do.



Sometimes executives simply have to function without much sleep. What are some strategies they can use to get by until they can go to bed?

Though there is no known substitute for sleep, there are a few strategies you can use to help sustain performance temporarily until you can get a good night's sleep. Obviously, executives can drink caffeine, which is the most widely used wake-promoting therapeutic in the world. Naps can be very effective at restoring performance, and if they are brief—less than a half hour—they will induce less grogginess upon awakening. Being in a novel or engaging circumstance will also help you stay alert. Exercise, standing in an upright position, and exposure to bright light are all very helpful. Human beings are amazingly sensitive to light. In fact, the color of light may also be important. Exposure to shorter wavelength blue light is particularly effective in suppressing melatonin production, thereby allowing us to stay awake during our biological night. Photon for photon, looking up at the blue sky, for example, is more effective in both resetting our biological clock and enhancing our alertness than looking down at the green grass.

While all these things can help an executive function in an emergency, I must reiterate that he or she should still not drive when sleep deprived, even if a cup of coffee or a walk on a sunny day seems to help for a little while.

Do you get enough sleep?

Like everyone else, I try to, but I don't always achieve it.

1. Dr. Czeisler is the incumbent of an endowed professorship donated to Harvard by Cephalon and consults for a number of companies, including Actelion, Cephalon, Coca-Cola, Hypnion, Pfizer, Respireonics, Sanofi-Aventis, Takeda, and Vanda.

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What's New in Sleep?

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Sleep science is advancing on a number of frontiers that, over time, may cause us to rethink everything from our personal habits to public policy. Here's a short sampling of these new developments.

Sleep is power. Your mother was right—to perform at your best, you need sleep. Discoveries about sleep cycles have given researchers new insight into the specific roles sleep plays in overall health and performance. For example, there is growing evidence that sleep aids in immune function, memory consolidation, learning, and organ function. “Some researchers now think sleep may be the missing link when it comes to overall health, safety, and productivity,” says Darrel Droblich, the senior director of government and transportation affairs for the National Sleep Foundation. One new field of study is looking at a specific correlation between sleep and productivity, and the benefits of what sleep researchers call a “power nap”—a 20-minute period of sleep in the afternoon that heads off problems associated with cumulative sleep deficit.

Move over, Ambien. Ambien, the sleep aid from drugmaker Sanofi-Aventis, is

now de rigueur for the sleepless, ringing up \$1.4 billion annually in U.S. sales alone. While Ambien has fewer side effects than most over-the-counter sleep aids, it's still a blunt instrument, neurophysiologically speaking. "All of the current products on the market, including Ambien, take a sledgehammer to specific receptors in the brain," says Dr. Robert McCarley, the head of psychiatry at Boston VA Medical Center and a professor of psychiatry at Harvard Medical School. "They have several negative side effects, ranging from disassociated states of consciousness to potential addiction. They also tend to lose their effectiveness over time." Researchers hope a new family of sleep-inducing drugs will function closer to the body's natural sleep mechanisms and so avoid problems associated with sedatives like Ambien. One such new drug—Rozerem, from Japanese drug giant Takeda—targets melatonin receptors in the brain. As researchers learn more about the body's internal sleep mechanisms, McCarley believes, sleep aids will inevitably improve.

On the other side of the equation, the pharmaceutical company Cephalon is now marketing modafinil, a drug that helps people function well on very little sleep without suffering the ill effects of common stimulants. Sold under the commercial trade name Provigil in the U.S., modafinil was originally prescribed to treat narcolepsy; it's now used to promote wakefulness among those who can't afford to go to sleep (such as field soldiers in war zones). Studies have shown that subjects taking modafinil are able to stay alert with only eight hours of sleep during an 88-hour period. While modafinil sounds like a dream drug, no one yet knows what effects may result from more than occasional use.

Car drowse alarms. By the end of the decade, automakers will offer cars outfitted with devices designed to keep drowsy drivers from falling asleep at the wheel. Some may use cameras to scan drivers' eyes for droopiness, or to sense when people are loosening their grip on the steering wheel, and then sound an alarm. In 2005, Ford and Volvo announced that they were working on a system called Driver Alert, consisting of a camera that measures the distance between the vehicle and the markings on the surface of the road. If the driver starts to swerve, an alarm goes off and a text warning appears on the dashboard. Another approach under consideration by the U.S. National Highway Traffic Safety Administration is the development of "intelligent" highways equipped with specialized sensors that continuously track vehicle trajectory and speed.

Tomorrow's workforce needs sleep now. Businesses need an educated workforce; ironically, school is interfering. The current high school schedule in the U.S., which typically begins around 7:20 AM, threatens the neurological development and health of adolescents, whose homeostatic drive operates differently from adults'. Most teens experience a delayed sleep phase, in which melatonin is released around 11 PM—an hour later than in most adults. Students who finally go to sleep by midnight and wake at 6 experience a chronic sleep deficit, which disrupts their ability to learn and puts them and you at risk on the roads. In the U.S., researchers and sleep advocates are now working closely with school districts, communities, and educators to change school start times so that students can get more sleep.

—Bronwyn Fryer

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