and wakefulness is a subject of speculation; Czeisler says that long bouts of wakefulness may enable us to "take advantage of our greater intellectual capacity by focusing our energy and concentration. Frequent catnaps would interrupt that."

The circadian pacemaker's push for wakefulness peaks between about 8 and 10 P.M., which makes it very difficult for someone on a typical schedule to fall asleep then. "The period from two to three hours before one's regular bedtime, we call a 'wake maintenance zone,' " Czeisler says. But about an hour before bedtime, the pineal gland steps up its secretion of the hormone melatonin, which quiets the output from the SCN and hence paves the way for sleep.

Some years ago, melatonin supplements became popular as a natural sleeping pill, but as Czeisler's research has proven, light is a more powerful influence on the biological clock than melatonin. Mangelsdorf professor of natural sciences J. Woodland Hastings has shown that even a split-second of light exposure can shift the circadian cycle of a single-celled organism by a full hour. Light interferes with sleep, at least partly because it inhibits melatonin secretion and thus resets the biological clock. For this reason, those seeking a sound sleep should probably keep their bedroom as dark as possible and by all means avoid midnight trips to brightly lit bathrooms or kitchens; blue light, with its shorter wavelength—and its resemblance to the sunlit sky—has the most powerful resetting effect.

Light resets the pacemaker even in the case of some completely blind people, who generally lose circadian entrainment and suffer recurrent insomnia. "The eye has two functions, just as the ear does, with hearing and balance," says Czeisler. "The eye has vision, and also circadian photoreception." A subset of about 1,000 photosensitive retinal ganglion cells connects by a direct neural pathway to the SCN; these cells are sometimes active even in those who are blind to light. Exposure to bright light will decrease melatonin levels in some blind persons, and this subset, unlike other blind people, generally do not suffer from insomnia and are biologically entrained to the 24-hour day.

Disastrous Exhaustion

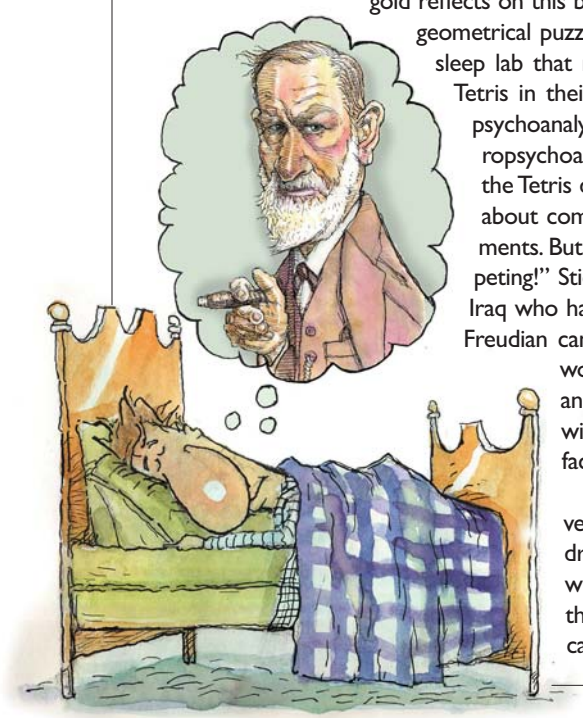
THE HUMAN SPECIES, or much of it, anyway, apparently is trying to become simultaneously nocturnal and diurnal. Society has been squeezing the window for restful sleep ever narrower. (Czeisler likes to quote

Freud's Guesswork on Dreams

One of Sigmund Freud's great complaints about his mistreatment in life was that although he won a literary award for his famous book *The Interpretation of Dreams* (1900), it never received a scientific award. A century later, his peers' judgment has been vindicated. Freud's unscientific theory of dreams—based on self-analysis and a cherry-picked group of clinical anecdotes—has been demolished by the discoveries of sleep medicine. "I came into the field so far post-Freudian that Freud felt like someone with a goofy theory two centuries back," says Robert Stickgold, associate professor of psychiatry, who has studied dreams in sleep studies for years, often in collaboration with professor of psychiatry J. Allan Hobson. "The Greeks tried to explain thunder and lightning by creating gods; Freud tried to explain dreams by creating demons like the id and repressed desires," says Stickgold. "In general, Freud's dream theories have been remarkably resistant to scientific confirmation. He made a lot of observations that are quite prescient, but his attempt to build a model to explain them is completely wrong and there is no piece of it that holds up."

For example, Freud thought we dream to keep ourselves from being awakened. "That's absolutely false," says Stickgold. "Freud thought that as we sleep, with constraints on the id reduced, all these nasty Victorian desires well up, and if they were allowed to come into the conscious mind, they would be so distressing that the sleeper would wake up. So dreaming is all about disguising and transforming these desires to make them more acceptable to the conscious mind. Freud probably was assuming that people dream one or two times a night, for a few minutes—most people think that, since that's what we remember on waking. But since the 1960s, it's been clear that we dream most of the night—six hours out of eight hours of sleep. During the Rapid Eye Movement (REM) phases of sleep, which make up 15 to 20 percent of sleep time, we do have our most intense dreaming activity, but we dream in other sleep phases, too. If dreaming is all about repressed childhood desires, does everybody have the same amount of them?"

Another core tenet of Freud's dream theory is that a dream is the fulfillment of a wish. Stickgold reflects on this by describing a study using the game Tetris, a kind of geometrical puzzle. Subjects were taught to play the game, and in a sleep lab that night, 60 to 75 percent of them saw images from Tetris in their dreams. "Someone asked Mark Solms, a brilliant psychoanalyst who is trying to create a new field called neuropsychoanalysis—an oxymoron if I ever heard one—about the Tetris dream imagery. He said, 'Those are probably dreams about competition and winning'—in other words, wish fulfillments. But nobody dreamed about winning the game or competing!" Stickgold also wonders about a mother with a son in Iraq who has nightmares about her child being killed. "Maybe a Freudian can interpret that as wish-fulfillment," he says. "But I would take that as perverse, and blind adherence to an outdated model. Any dream can be interpreted as wish fulfillment, but there's no evidence that it is. In fact, there's tons of evidence against it."



Entering into the interpretation of dreams "gets very messy," Stickgold says. "If I could give the same dream to 10 analysts and they all said, 'This is about a wish for immortality,' then I could say, 'OK, at least they all agree on the same interpretation.' But they can't even do that."