Internal Time: The Science of Social Jet Lag
by Maria Popova

Debunking the social stigma around late risers, or what Einstein has to do with teens' risk for smoking.

"Six hours' sleep for a man, seven for a woman, and eight for a fool," Napoleon famously prescribed. (He would have scoffed at Einstein, then, who was known to require ten hours of sleep for optimal performance.) This perceived superiority of those who can get by on less sleep isn't just something Napoleon shared with dictators like Hitler and Stalin, it's an enduring attitude woven into our social norms and expectations, from proverbs about early birds to the basic scheduling structure of education and the workplace. But in Internal Time: Chronotypes, Social Jet Lag, and Why You're So Tired, a fine addition to these 7 essential books on time, German chronobiologist Till Roenneberg demonstrates through a wealth of research that our sleep patterns have little to do with laziness and other such scorned character flaws, and everything to do with biology.

In fact, each of us possesses a different chronotype — an internal timing type best defined by your midpoint of sleep, or midsleep, which you can calculate by dividing your average sleep duration by two and adding the resulting number to your average bedtime on free days, meaning days when your sleep and waking times are not dictated by the demands of your work or school schedule. For instance, if you go to bed at 11 P.M. and wake up at 7 A.M., add four hours to 11pm and you get 3 A.M. as your midsleep.

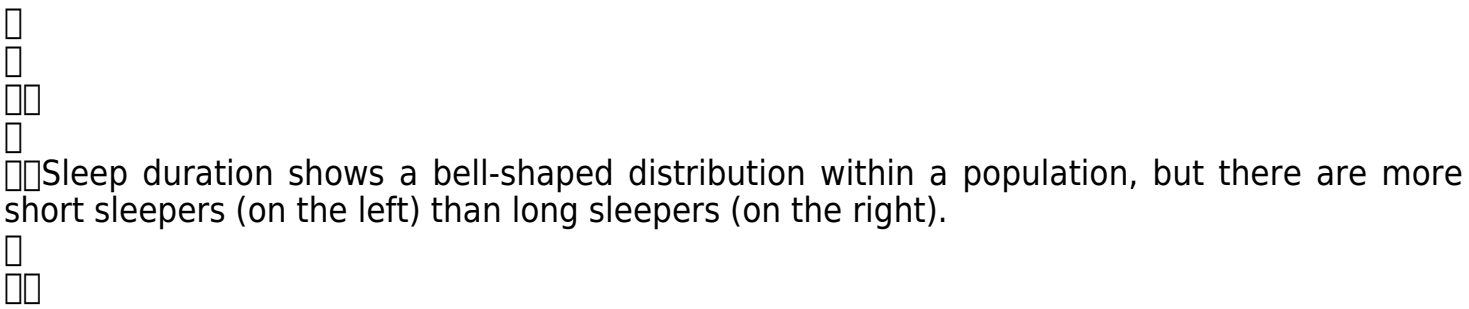
The distribution of midsleep in Central Europe. The midsleep times (on free days) of over 60 percent of the population fall between 3:30 and 5:30 A.M.

Roenneberg traces the evolutionary roots of different sleep cycles and argues that while earlier chronotypes might have had a social advantage in agrarian and industrial societies, today's world of time-shift work and constant connectivity has invalidated such advantages but left behind the social stigma around later chronotypes.

This myth that early risers are good people and that late risers are lazy has its reasons and merits in rural societies but becomes questionable in a modern 24/7 society. The old moral is so prevalent, however, that it still dominates our beliefs, even in modern times.

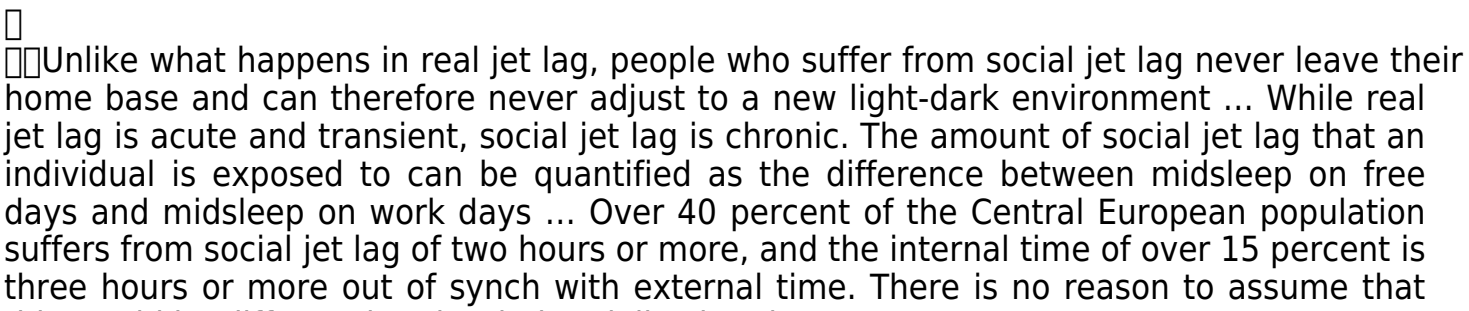
The postman doesn’t think for a second that the young man might have worked until the early morning hours because he is a night-shift worker or for other reasons. He labels healthy young people who sleep into the day as lazy — as long sleepers. This attitude is reflected in the frequent use of the word-pair early birds andlong sleepers [in the media]. Yet this pair is nothing but apples and oranges, because the opposite of early is late and the opposite of long is short.

Roenneberg goes on to explore sleep duration, a measure of sleep types that complements midsleep, demonstrating just as wide a spectrum of short and long sleepers and debunking the notion that people who get up late sleep longer than others — this judgment, after all, is based on the assumption that everyone goes to bed at the same time, which we increasingly do not.

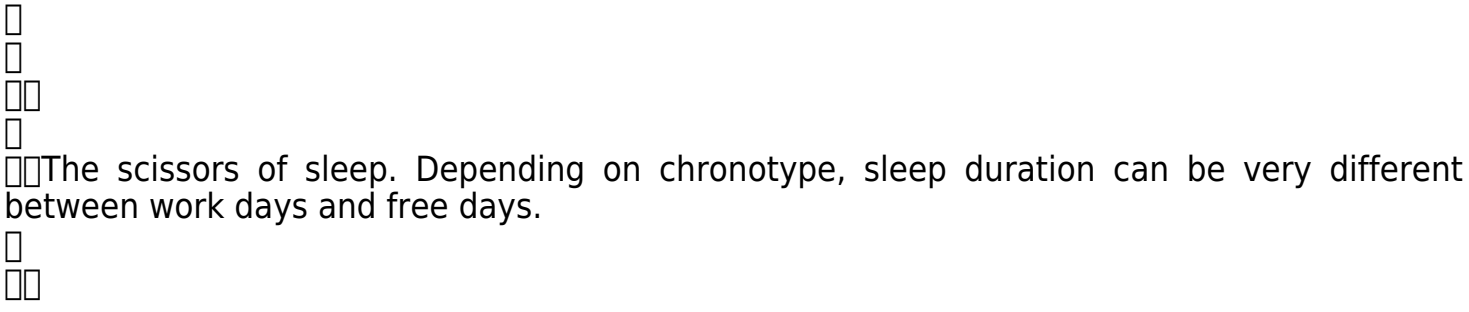


Sleep duration shows a bell-shaped distribution within a population, but there are more short sleepers (on the left) than long sleepers (on the right).

The disconnect between our internal, biological time and social time — defined by our work schedules and social engagements — leads to what Roenneberg calls social jet lag, a kind of chronic exhaustion resembling the symptoms of jet lag and comparable to having to work for a company a few time zones to the east of your home.



Unlike what happens in real jet lag, people who suffer from social jet lag never leave their home base and can therefore never adjust to a new light-dark environment … While real jet lag is acute and transient, social jet lag is chronic. The amount of social jet lag that an individual is exposed to can be quantified as the difference between midsleep on free days and midsleep on work days … Over 40 percent of the Central European population suffers from social jet lag of two hours or more, and the internal time of over 15 percent is three hours or more out of synch with external time. There is no reason to assume that this would be different in other industrialized nations.



The scissors of sleep. Depending on chronotype, sleep duration can be very different between work days and free days.

Chronotypes vary with age:

Young children are relatively early chronotypes (to the distress of many young parents), and then gradually become later. During puberty and adolescence humans become true night owls, and then around twenty years of age reach a turning point and become earlier again for the rest of their lives. On average, women reach this turning point at nineteen and a half while men start to become earlier again at twenty-one … [T]his clear turning point in the developmental changes of chronotype … [is] the first biological marker for the end of adolescence.

Roenneberg points out that in our culture, there is a great disconnect between teenagers' biological abilities and our social expectations of them, encapsulated in what is known as the disco hypothesis — the notion that if only teens would go to bed earlier, meaning not party until late, they'd be better able to wake up clear-headed and ready for school at the expected time. The data, however, indicate otherwise — adolescents' internal time is shifted so they don't find sleep before the small hours of the night, a pattern also found in the life cycle of rodents.

Here, we brush up against a painfully obtrusive cultural obstacle: School starts early — as early as 7 A.M. in some European countries — and teens are expected to perform well on a schedule not designed with their internal time in mind. As a result, studies have shown that many students show the signs of narcolepsy — a severe sleeping disorder that makes one fall asleep at once when given the chance, immediately entering REM sleep. The implications are worrisome:

Teenagers need around eight to ten hours of sleep but get much less during their workweek. A recent study found that when the starting time of high school is delayed by an hour, the percentage of students who get at least eight hours of sleep per night jumps from 35.7 percent to 50 percent. Adolescent students' attendance rate, their performance, their motivation, even their eating habits all improve significantly if school times are delayed.

(Speaking from experience, this could also be extrapolated about work times and professional event times — conference organizers, are you paying attention?)

Roenneberg cites a Danish project, which eliminated timetables entirely and left the decision about when to arrive at school up to the students, based on a vision that schools should be regarded as service centers that tailor their service to what's best for their customers — an optimal environment for achieving the best education possible.

Similar detrimental effects of social jet lag are found in shift work, which Roenneberg calls "one of the most blatant assaults on the body clock in modern society." (And while we may be tempted to equate shift work with the service industry, any journalist, designer, developer, or artist who works well into the night on deadline can relate — hey, it's well past midnight again as I'm writing this.) In fact, the World Health Organization recently classified "shift work that involves circadian disruption" as a potential cause of cancer, and the consequences of social jet lag and near-narcolepsy extend beyond the usual suspects of car accidents and medical errors:

We are only beginning to understand the potentially detrimental consequences of social jet lag. One of these has already been worked out with frightening certainty: the more

severe the social jet lag that people suffer, the more likely it is that they are smokers. Tis is not a question of quantity (number of cigarettes per day) but simple whether they are smokers or not … Statistically, we experience the worst social jet lag as teenagers, when our body clocks are drastically delayed for biological reasons, but we still have to get up at the same traditional times for school. This coincides with the age when most individuals start smoking. Assuredly there are many different reasons people start smoking at that age, but social jet lag certainly contributes to the risk.

If young people's psychological and emotional well-being isn't incentive enough for policy makers — who, by the way, Roenneberg's research indicates tend to be early chronotypes themselves — to consider later school times, one would think their health should be.

The correlation between social jet lag and smoking continues later in life as well, particularly when it comes to quitting:

> [T]he less stress smokers have, the easier it is for them to quit. Social jet lag is stress, so the chances of successfully quitting smoking are higher when the mismatch of internal and external time is smaller. The numbers connecting smoking with social jet lag are striking: Among those who suffer less than an hour of social jet lag per day, we find 15 to 20 percent are smokers. This percentage systematically rises to over 60 percent when internal and external time are more than five hours out of sync.

Another factor contributing to our social jet lag is Daylight Savings Time. Even though DST's proponents argue that it's just one small hour, the data suggest that between October and March, DST throws off our body clocks by up to four weeks, depending on our latitude, not allowing our bodies to properly adjust to the time change, especially if we happen to be later chronotypes. The result is increased social jet lag and decreased sleep duration.

But what actually regulates our internal time? Though the temporal structures of sun time — tide, day, month, and year — play a significant role in the lives of all organisms, our biological clocks evolved in a "time-free" world and are somewhat independent of such external stimuli as light and dark. For instance, early botanical studies showed that a mimosa plant kept in a pitch-dark closet would still open and close its leaves the way it does in the day-night cycle, and subsequent studies of human subjects confined to dark bunkers showed similar preservation of their sleep and waking patterns, which followed, albeit imperfectly, the 24-hour cycle of day and night.

Our internal clocks, in fact, can be traced down to the genetic level, with individual "clock genes" and, most prominently, the suprachiasmatic nucleus, or SCN — a small region in the brain's midline that acts as a kind of "master clock" for mammals, regulating neuronal and hormonal activity around our circadian rhythms. Roenneberg explains how our internal clocks work on the DNA level:

> In the nucleus, the DNA sequence of a clock gene is transcribed to mRNA; the resulting message is exported from the nucleus, translated into a clock protein, and is then modified. This clock protein is itself part of the molecular machinery that controls the transcription of its 'own' gene. When enough clock proteins have been made, they are imported back into the nucleus, where they start to inhibit the transcription of their own

mRNA. Once this inhibition is strong enough, no more mRNA molecules are transcribed, and the existing ones are gradually destroyed. As a consequence, no more proteins can be produced and the existing ones will also gradually be destroyed. When they are all gone, the transcriptional machinery is not suppressed anymore, and a new cycle can begin.

[…]

Despite this complexity, the important take-home message is that daily rhythms are generated by molecular mechanisms that could potentially work in a single cell, for example a single neuron of the SCN.

So, even if philosopher Daniel Dennett's is right in that "not a single one of the cells that compose you knows who you are, or cares," a single cell does know when you should be sleeping and cares.

Still, external cues do synchronize our internal clocks, via a process calledentrainment to make the internal day fit the external one by either compression or expansion. Light and darkness are the most potent of these cues. For most humans, our internal clocks are slightly longer than 24 hours, so they need compression. To achieve this, a body clock exposes more of its internal "day" to light and hides some of its internal "night" in the dark. This results in internal time being slightly later than external time, which is why people with slow internal clocks end up being later chronotypes.

Light, indeed, is the most important external cue to synchronize our internal body clocks, and the lack of light can have severe negative effects on our sleep patterns. Even a well-lit workplace exposes us to no more than 100 Lux, which translates to 1,200 Lux-hours over the course of a 12-hour workday. Meanwhile, on a cloudy day, the intensity of outside light is about 120,000 Lux, which means even a short 20-minute walk outdoors would expose us to 40,000 Lux-hours, or more than thirty-fold the exposure of that entire indoor workday. (Unless you have one of these lamps, which has been the single most important investment in my circadian sanity and general tolerance of dreary New York winters since my meditation practice.)

The detrimental effects of this light deprivation are most pronounced in the elderly and the mentally ill. Many elderly people rarely get a chance to go outside, and the TV is often their primary source of light. (Which leads one to wonder why elderly homes and assisted living facilities aren't investing in such artificial daylight lamps rather than the countless flatscreen TVs gracing the common areas and even individual rooms in these institutions.)

Across most ages, men are on average later chronotypes than women. The differences decrease as men and women age. Thus, when the man is older than his female partner, their chronotypes tend to be more similar.

Internal Time goes on to illuminate many other aspects of how chronotypes and social jet

lag impact our daily lives, from birth and suicide rates to when we borrow books from the library to why older men marry younger women, and even why innovators and entrepreneurs tend to have later chronotypes. (One hypothesis: because they were more challenged in school than early types, and always had to invent clever strategies to help them perform despite not being on top of things.)

Roenneberg's daughter put together this wonderful teaser for her father's research:

(Thanks, Jalees.)

Ultimately, Roenneberg makes a powerful case against many of the social expectations we have around sleep and productivity:

> I am often asked whether we cannot get used to given working hours merely through discipline and by confining our sleep habits to certain times. The assumption inherent in this question is that the human body clock can synchronize to social cues. I tend to find that any such questioner, who usually also displays a somewhat disdainful tone towards the weakness of late chronotypes, is an early type — someone who has never experienced the problems associated with the [desynchronized] sleep-wake behavior of late chronotypes.