

- “If sleep does not serve an absolutely vital function, then it is the biggest mistake the evolutionary process has ever made.”^{fn3}

- sleep is the single most effective thing we can do to reset our brain and body health each day—Mother

- For every day you are in a different time zone, your suprachiasmatic nucleus can only readjust by about one hour.

- Caffeine works by successfully battling with adenosine for the privilege of latching on to adenosine welcome sites—or receptors—in the brain.

- The practice of biphasic sleep is not cultural in origin, however. It is deeply biological. All humans, irrespective of culture or geographical location, have a genetically hardwired dip in alertness that occurs in the midafternoon hours.

- None of the individuals had a history of coronary heart disease or stroke at the start of the study, indicating the absence of cardiovascular ill health. However, those that abandoned regular siestas went on to suffer a 37 percent increased risk of death from heart disease across the six-year period, relative to those who maintained regular daytime naps. The effect was especially strong in workingmen, where the ensuing mortality risk of not napping increased by well over 60 percent. Apparent from this remarkable study is this fact: when we are cleaved from the innate practice of biphasic sleep, our lives are shortened. It is perhaps unsurprising that in the small enclaves of Greece where siestas still remain intact, such as the island of Ikaria, men are nearly four times as likely to reach the age of ninety as American males. These napping communities have sometimes been described as “the places where people forget to die.” From a prescription written long ago in our ancestral genetic code, the practice of natural biphasic sleep, and a healthy diet, appear to be the keys to a long-sustained life.

- Become too relaxed in your sleep depth when slouched on a branch or in a nest, and a dangling limb may be all the invitation gravity needs to bring you hurtling down to Earth in a life-ending fall, removing you from the gene pool.

- the coolheaded ability to regulate our emotions each day—a key to what we call emotional IQ—depends on getting sufficient REM sleep night after night.

- we can start to see how this nightly REM-sleep recalibration of our emotional brains could have scaled rapidly and exponentially. From this REM-sleep-enhanced emotional IQ emerged a new and far more sophisticated form of hominid socioecology across vast collectives, one that helped enable the creation of large, emotionally astute, stable, highly bonded, and intensely social communities of humans. I will go a step further and suggest that this is the most influential function of REM sleep in mammals, perhaps the most influential function of all types of sleep in all mammals, and even the most eminent advantage ever gifted by sleep in the annals of all planetary life.

- What may at first blush have seemed like a modest asset awarded by REM sleep to a single individual is, I believe, one of the most valuable commodities ensuring the survival and dominance of our species as a collective.

- The second evolutionary contribution that the REM-sleep dreaming state fuels is creativity.
- Despite aeons of opportunity time, neither species has visited the moon, created computers, or developed vaccines. Humbly, we humans have. Sleep, especially REM sleep and the act of dreaming, is a tenable, yet underappreciated, factor underlying many elements that form our unique human ingenuity and accomplishments, just as much as language or tool use (indeed, there is even evidence that sleep causally shapes both these latter traits as well).
- But we do know that REM sleep is vital for promoting brain maturation.
- Think of REM sleep like an Internet service provider that populates new neighborhoods of the brain with vast networks of fiber-optic cables.
- Alcohol is one of the most powerful suppressors of REM sleep that we know of.
- Their mothers were assessed on two successive days. On one of those days, the mothers drank non-alcoholic fluids. On the other day, they drank approximately two glasses of wine (the absolute amount was controlled on the basis of their body weight). Alcohol significantly reduced the amount of time that the unborn babies spent in REM sleep, relative to the non-alcohol condition.
- What emerges from all of these studies is that REM sleep is not optional during early human life, but obligatory.
- The changes in deep NREM sleep always precede the cognitive and developmental milestones within the brain by several weeks or months, implying a direction of influence: deep sleep may be a driving force of brain maturation, not the other way around.
- We will come to learn that sleep is the universal health care provider: whatever the physical or mental ailment, sleep has a prescription it can dispense. Upon completion of these chapters, I hope even the most ardent of short-sleepers will be swayed, having a reformed deference.
- 1611 in Macbeth, act two, scene two, where Shakespeare prophetically states that sleep is “the chief nourisher in life’s feast.”^{fn1}
- Those who were awake throughout the day became progressively worse at learning, even though their ability to concentrate remained stable (determined by separate attention and response time tests). In contrast, those who napped did markedly better, and actually improved in their capacity to memorize facts. The difference between the two groups at six p.m. was not small: a 20 percent learning advantage for those who slept.
- In doing so, sleep had delightfully cleared out the hippocampus, replenishing this short-term information repository with plentiful free space. Participants awoke with a refreshed capacity to absorb new information within the hippocampus, having relocated yesterday’s imprinted experiences to a more permanent safe hold. The learning of new facts could begin again, anew, the following day.
- Of broader societal relevance, the concentration of NREM-sleep spindles is especially rich in the late-morning hours, sandwiched between long periods of REM sleep. Sleep six hours or

less and you are shortchanging the brain of a learning restoration benefit that is normally performed by sleep spindles.

- The first such claim in the written human record appears to be by the prophetic Roman rhetorician Quintilian (AD 35–100), who stated: It is a curious fact, of which the reason is not obvious, that the interval of a single night will greatly increase the strength of the memory Whatever the cause, things which could not be recalled on the spot are easily coordinated the next day, and time itself, which is generally accounted one of the causes of forgetfulness, actually serves to strengthen the memory.^{fn3}

- could predict with high accuracy how much you would remember in the upcoming memory test upon awakening, even before you took it. That's how deterministic the link between sleep and memory consolidation can be.

- In other words, following a night of sleep you regain access to memories that you could not retrieve before sleep. Like a computer hard drive where some files have become corrupted and inaccessible, sleep offers a recovery service at night.

- After being awake for nineteen hours, people who were sleep-deprived were as cognitively impaired as those who were legally drunk.

- In fact, participants in the above study started their nosedive in performance after just fifteen hours of being awake (ten p.m. in the above scenario).

- Get behind the wheel of a car when having slept just four hours or less the night before and you are 11.5 times more likely to be involved in a car accident.

- The heady cocktail of sleep loss and alcohol was not additive, but instead multiplicative

- The recycle rate of a human being is around sixteen hours. After sixteen hours of being awake, the brain begins to fail. Humans need more than seven hours of sleep each night to maintain cognitive performance. After ten days of just seven hours of sleep, the brain is as dysfunctional as it would be after going without sleep for twenty-four hours.

- We have, however, discovered a very rare collection of individuals who appear to be able to survive on six hours of sleep, and show minimal impairment—a sleepless elite, as it were. Give them hours and hours of sleep opportunity in the laboratory, with no alarms or wake-up calls, and still they naturally sleep this short amount and no more. Part of the explanation appears to lie in their genetics, specifically a sub-variant of a gene called BHLHE41.

- Adults forty-five years or older who sleep fewer than six hours a night are 200 percent more likely to have a heart attack or stroke during their lifetime, as compared with those sleeping seven to eight hours a night.

- Between 35 and 55 percent of emotional themes and concerns that participants were having while they were awake during the day powerfully and unambiguously resurfaced in the dreams they were having at night.

- You have not forgotten the memory, but you have cast off the emotional charge, or at least a significant amount of it. You can accurately relive the memory, but you do not regurgitate

the same visceral reaction that was present and imprinted at the time of the episode.^{fn1} The theory argued that we have REM-sleep dreaming to thank for this palliative dissolving of emotion from experience.

- So profound was this dream-implanted discovery that it won Loewi a Nobel Prize.
- Moreover, the way in which the participants were solving the problems after exiting REM sleep was different from how they solved the problems both when emerging from NREM sleep and while awake during the day.
- As we enter REM sleep and dreaming takes hold, an inspired form of memory mixology begins to occur. No longer are we constrained to see the most typical and plainly obvious connections between memory units. On the contrary, the brain becomes actively biased toward seeking out the most distant, nonobvious links between sets of information. This widening of our memory aperture is akin to peering through a telescope from the opposing end. When we are awake we are looking through the wrong end of the telescope if transformational creativity is our goal. We take a myopic, hyperfocused, and narrow view that cannot capture the full informational cosmos on offer in the cerebrum. When awake, we see only a narrow set of all possible memory interrelationships. The opposite is true, however, when we enter the dream state and start looking through the other (correct) end of the memory-surveying telescope. Using that wide-angle dream lens, we can apprehend the full constellation of stored information and their diverse combinatorial possibilities,
- John Steinbeck wrote, "A problem difficult at night is resolved in the morning after the committee of sleep has worked on it."
- Edison would allegedly position a chair with armrests at the side of his study desk, on top of which he would place a pad of paper and a pen. Then he would take a metal saucepan and turn it upside down, carefully positioning it on the floor directly below the right-side armrest of the chair. If that were not strange enough, he would pick up two or three steel ball bearings in his right hand. Finally, Edison would settle himself down into the chair, right hand supported by the armrest, grasping the ball bearings. Only then would Edison ease back and allow sleep to consume him whole. At the moment he began to dream, his muscle tone would relax and he would release the ball bearings, which would crash on the metal saucepan below, waking him up. He would then write down all of the creative ideas that were flooding his dreaming mind. Genius, wouldn't you agree?
- During REM sleep, however, all voluntary muscles are paralyzed, preventing the dreamer from acting out ongoing mental experience.
- First, when you read the paper, you will learn that the tribespeople were actually giving themselves a 7- to 8.5-hour sleep opportunity each night. Moreover, the wristwatch device, which is neither a precise nor gold standard measure of sleep, estimated a range of 6 to 7.5 hours of this time was spent asleep. The sleep opportunity that these tribespeople provide themselves is therefore almost identical to what the National Sleep Foundation and the Centers for Disease Control and Prevention recommend for all adult humans: 7 to 9 hours of time in bed.

- The problem is that some people confuse time slept with sleep opportunity time. We know that many individuals in the modern world only give themselves 5 to 6.5 hours of sleep opportunity, which normally means they will only obtain around 4.5 to 6 hours of actual sleep. So no, the finding does not prove that the sleep of hunter-gatherer tribes is similar to ours in the post-industrial era. They, unlike us, give themselves more sleep opportunity than we do.

- Those taking the highest dose of zolpidem (Ambien) were still vulnerable, suffering almost a 30 percent greater likelihood of developing cancer across the two-and-a-half-year study duration. Interestingly, animal experiments

- Give participants the ability to choose between work tasks of varying effort, from easy (e.g., listening to voice mails) to difficult (e.g., helping design a complex project that requires thoughtful problem solving and creative planning), and you find that those individuals who obtained less sleep in the preceding days are the same people who consistently select less challenging problems. They opt for the easy way out, generating fewer creative solutions in the process. It is, of course, possible that the

- There are, however, an increasing number of forward-looking companies who have changed their work practices in response to these research findings, and even welcome scientists like me into their businesses to teach and extol the virtues of getting more sleep to senior leaders and management. Procter & Gamble Co. and Goldman Sachs Group Inc., for example, both offer free “sleep hygiene” courses to their employees. Expensive, high-grade lighting has been installed in some of their buildings to better help workers regulate their circadian rhythms, improving the timed release of melatonin. Nike and Google have both adopted a more relaxed approach to work schedules, allowing employees to time their daily work hours to match their individual circadian rhythms and their respective owl and lark chronotype nature. The change in mind-set is so radical that these same brand-leading

- make no mistake: companies like Nike and Google are as shrewd as they are profitable. They embrace sleep due to its proven dollar value.

- NASA refined the science of sleeping on the job for the benefit of their astronauts. They discovered that naps as short as twenty-six minutes in length still offered a 34 percent improvement in task performance and more than a 50 percent increase in overall alertness.

- Could you concentrate and learn much of anything when you had woken up so early? Keep in mind that 5:15 a.m. to a teenager is not the same as 5:15 a.m. to an adult. Previously, we noted that the circadian rhythm of teenagers shifts forward dramatically by one to three hours. So really the question I should ask you, if you are an adult, is this: Could you concentrate and learn anything after having forcefully been woken up at 3:15 a.m., day after day after day? Would you be in a cheerful mood? Would you find it easy to get along with your coworkers and conduct yourself with grace, tolerance, respect, and a pleasant demeanor? Of course not. Why, then, do we ask this of the millions of teenagers and children in industrialized nations? Surely this is not an optimal design of education.

- Only then did scientists realize the rather profound conclusions of the experiment: REM sleep is what stands between rationality and insanity. Describe these symptoms to a psychiatrist

without informing them of the REM-sleep deprivation context, and the clinician will give clear diagnoses of depression, anxiety disorders, and

- It is the lack of REM sleep—that critical stage occurring in the final hours of sleep that we strip from our children and teenagers by way of early school start times—that creates the difference between a stable and unstable mental state.

- Based on recent surveys and clinical evaluations, we estimate that more than 50 percent of all children with an ADHD diagnosis actually have a sleep disorder, yet a small fraction know of their sleep condition and its ramifications. A major public health awareness campaign by governments—perhaps

- As I write this chapter, a new report has discovered that medical errors are the third-leading cause of death among Americans after heart attacks and cancer. Sleeplessness undoubtedly plays a role in those lives lost.

- The next time you see a doctor in a hospital, keep in mind the study we have previously discussed, showing that after twenty-two hours without sleep, human performance is impaired to the same level as that of someone who is legally drunk.

- When it comes to the quantified self, it's the old adage of "seeing is believing" that ensures longer-term adherence to healthy habits.

- Going even further, what if we moved from a stance of analytics (i.e., here is your past and/or current sleep and here is your past and/or current body weight) to that of forward-looking predictalytics? To explain the term, let me go back to the smoking example. There are efforts to create predictalytics apps that start with you taking a picture of your own face with the camera of your smartphone.

- First, to employees in the workplace. The giant insurance company Aetna, which has almost fifty thousand employees, has instituted the option of bonuses for getting more sleep, based on verified sleep-tracker data. As Aetna chairman and CEO Mark Bertolini described, "Being present in the workplace and making better decisions has a lot to do with our business fundamentals." He further noted, "You can't be prepared if you're half asleep." If workers string together twenty seven-hour nights of sleep or more in a row, they receive a twenty-five-dollar-per-night bonus, for a (capped) total of five hundred dollars.

- Within the space of a mere hundred years, human beings have abandoned their biologically mandated need for adequate sleep—one that evolution spent 3,400,000 years perfecting in service of life-support functions. As a result, the decimation of sleep throughout industrialized nations is having a catastrophic impact on our health, our life expectancy, our safety, our productivity, and the education of our children.