

Why We Sleep

Unlocking the Power of Sleep and Dreams

By Matthew Walker, PhD

Part 1 This Thing Called Sleep

Chapter 1 To Sleep...

- **Two-thirds** of adults throughout developed nations fail to obtain the recommended eight hours of nightly sleep.
- Routinely sleeping less than six or seven a night doubles your risk of cancer and **increases diseases** such as Alzheimer's, stroke, and obesity.
- Sleeping doesn't serve us directly, we cannot eat, drink or reproduce, worse, it gets us vulnerable to predators. So **why did we evolve to sleep?**
- Sleeping has not one unique function but a **multitude of health benefits** that promote survival (ability to learn, memorize, make logical decisions, prevent infections, balance insulin, regulate appetite).
- **Modern society** has failed to explain to us the **crucial role of sleep**.

Chapter 2 Caffeine, Jet Lag, and Melatonin: Losing and Gaining Control of Your Sleep Rhythm

Got Rhythm?

- **Two factors** regulate our sleep: the twenty-four-hour clock in our brain and the chemical substance that accumulates when we are awake and makes us sleepy.
- The 24-hour clock communicates its daily **circadian rhythm** to our body determining when we want to be awake and we want to sleep.
- In 1729, the French geophysicist de Mairan discovered that **plants generate their own internal time**.
- The plant Mimosa pudica, even in darkness, would expand its leaves during the daytime, then retract them at the end of the day. **The plant kept track of the time without daylight.**
- In 1938, Professor Kleitman and his assistant Richardson stayed in the darkness of Mammoth Cave in Kentucky for 32 days as an **experiment**.
- Would their body temperature, wakefulness, and sleep become **erratic** without daylight?
- **Sleeping patterns** and wakefulness remained **predictable**.
- The second result is that the human circadian rhythm was not 24h but **24h and 15 minutes** in length.
- Human uses daylight and another signal (zeitgeber = synchronizer in German) as cues to reset our circadian rhythm to precisely 24h.
- This 24h clock is called the **suprachiasmatic nucleus**.
- Our circadian rhythm controls our **wakefulness and sleeps** whether we slept or not.

My rhythm is not your rhythm

- The circadian rhythm of **morning larks and night owls** is defined by **genetics**.
- A night owl who wakes up early, despite being awake, will remain in a sleep-like state.
- Sadly, **society is unfair towards night owls**: it is not their choice, and their work schedule is biased toward morning larks.
- Mother Nature programmed this **variability** to increase our **survival**. While morning larks are sleeping, night owls are watching, and vice versa.

Melatonin

- The suprachiasmatic nucleus instructs the rise of the **melatonin hormone** soon after dusk to **regulate the timing** of when sleep occurs.
- Melatonin **regulates the timing** of sleep but doesn't generate sleep.
- When you travel and feel **jet-lagged** (tired and sleepy), it is your 24h clock is not adapted yet to the new time zone. During the daytime, your clock still thinks it is nighttime.
- You can readjust by about one hour per day.
- Taking a **melatonin** pill can **trick** your brain it is nighttime.

Sleep pressure and caffeine

- The second factor to determine sleep is the **adenosine** chemical.
- Adenosine accumulates since you woke up and **pressure you to sleep**.
- **Caffeine** latches on receptors and blocks them. Adenosine cannot communicate the sleepiness signal normally to the brain.
- Your body takes around **7 hours to remove 50% of the caffeine** intake. If you take a coffee at 7:30 p.m., by 1:30 a.m. you still have half the caffeine circulating to your brain.
- Some people can eliminate caffeine much faster with a more efficient enzyme.
- People experience a "**caffeine crash**" when caffeine is finally removed, suddenly the adenosine that kept building up smothers the receptors left vacant.

In step, out of step

- The suprachiasmatic nucleus and adenosine are **two separate systems** that are **ignorant of each other** but are usually **aligned**.

Am I getting enough sleep?

- If you can fall back asleep at 10 a.m., and/or need a coffee before noon, you probably **lack sleep**.
- **Without enough sleep** (duration and quality), your level of **adenosine remains high**, and you will carry this sleepiness balance throughout the following day.

Chapter 3 Defining and Generating Sleep: Time Dilation and What We Learned from a Baby in 1952

Self-identifying sleep

- People sleeping have **several characteristics**: the body is horizontal, muscle tone is lowered, no responsivity or communication capacity, it is easily reversible, and it happens mostly during nighttime.
- When sleeping, our senses still perceive the outside world but our **thalamus** blocks the signal to our **cortex**.
- While asleep, we **lose conscious track of time** but our brain **keeps logging the time**.
- The scientific way to monitor sleep is through **brainwave** activity, **eye movement**, and **muscle activity**.

An infant revelation - Two types of sleep

- In 1952, Aserinsky monitored the **eye movement patterns** of infants.
- He noticed that there were periods of sleep when **the eyes were moving** and were accompanied by active brainwaves, almost identical to those observed from a brain that is wide awake.
- Other times, the eyes and brainwaves were calm.
- This pattern repeated several times throughout the night.

The sleep cycle

- Humans don't just sleep but **cycle** through two types of sleep: **NREM (non-rapid eye movement)** and **REM (rapid eye movement)** while dreaming.
- Sleep follows **cycles of 90 minutes** between NREM and REM.
- NREM stage is longer during the first cycle while REM is longer during the fifth cycle.

- If you sleep later, you will miss some NREM time, if you wake up earlier, you will lose NREM time that both serve different functions in our mind and body health.

How the brain generates sleep

- When **awake**, brainwaves are **fast and chaotic**.
- During deep slow-wave sleep, brainwaves decelerate to two to four waves per second.
- Thousand of brain cells coordinate together in **harmony**.
- Our brain is “reflecting”. Each wave moves memory **from short-term storage to safer long-term storage**.
- Our brain appears awake during the **paradoxical sleep**, and brainwaves are fast and desynchronized again.
- Our **thalamus** opens the gate, our cortex receives signals, not from the outside world but receives emotions, motivations, and memories.
- **REM sleep** is integrating our **past experiences**.
- At the time, our body is **paralyzed**. This immobilization allows scientists to recognize REM sleep brainwaves from wakeful ones.
- The brain **paralyzed** the body so the mind can **dream safely**.

Chapter 4 Ape Beds, Dinosaurs, and Napping with Half a Brain: Who Sleeps, How Do We Sleep, and How Much?

Who sleep

- **Sleep is universal**. Mollusks also sleep.
- Organisms have **different needs** for the total amount of sleep.

One of these things is not like the other

- This variation may come from the complexity of the brain relative to body size.
- Maybe measuring in **time is a wrong metric**, maybe those who sleep less have a **better quality** of sleep.
- The opposite has been discovered, those who sleep longer also have a deeper sleep.
- Causes: required time to **hunt and feed**, need for **rest**, and **socializing**.

To dream or not to dream

- Reptiles, insects, amphibians, and fish don't dream, they don't have REM sleep.
- Birds and mammals have REM sleep.
- However, some **aquatic mammals** have both NREM and REM sleep when they are on land.
- As birds and mammals evolved separately, REM sleep has been birthed twice.
- A reptile with REM sleep has been discovered in Australia, which means **REM sleep started 100 million years earlier**.
- What is the most important sleep, REM or NREM?
- After sleep deprivation, our **brain prioritizes NREM sleep**, then REM sleep during the following nights.

If only humans could

- Whales and dolphins can NREM sleep **half brain at a time**. The other half remains awake for them to keep swimming.
- For REM sleep, every species sleep with both sides of the brain.

Under pressure

- Under pressure, sleep patterns can be diminished. During fasting, humans and animals sleep less.
- During migration, birds can have sleep lasting only seconds in duration. The white-crowned sparrow can withstand sleep deprivation **without suffering ill effects** during its migration period.

How should we sleep?

- In our modern era, we sleep in a **monophasic pattern**, we sleep only once during the nighttime. But hunter-gatherer tribes have a **biphasic pattern** of sleep. They have a long sleep at night and a nap in the afternoon.
- They start sleeping at 9 p.m., “midnight” is the middle of the night for them.
- We also tend to want to sleep after lunch.
- In South America and Mediterranean Europe, **siesta** is still a cultural practice.
- A study shows in Greece that those who **abandoned siesta** suffer a 37% **increased risk of death from heart disease**.

We are special

- Compared to the other apes, **we sleep only eight hours**, relative to the ten or fifteen hours of sleep in other primates.
- **Our REM sleep is between 20 and 25 percent**, compared to an average of only 9 percent for the other primates.
- Primates sleep on trees but humans sleep on the floor.
- With fire, homo erectus and homo sapiens were able to **sleep on the ground** relatively safely. The fire would deter the predators and insects.
- To reduce the risk even further, we slept shorter in duration but **with more intensity**.
- Without the risk of falling from the trees, we can have more **high-quality REM sleep**.
- This **increase in REM sleep** may have enhanced our ability to make better decisions by understanding better emotions and social behaviors.
- The second benefit is it fueled **creativity and connected ideas**.

Chapter 5 Changes in Sleep Across the Life Span

Sleep before birth

- Before birth, the fetus spends most of its time sleeping.
- The movements of arms and legs are the consequences of the REM sleep.
- The brain has not built the **muscle-inhibiting system** to stop the body during the REM sleep.
- It is during the second and third semesters that the **REM sleep skyrockets** and the brain matures with the connection of millions of synapses.
- **Autism** is a neurological condition. The child has an **imbalance of synaptic connections**.
- They **lack social interaction** and have **different sleep patterns** with a 30% to 50% of deficit of REM sleep.
- **Alcohol** consumed by a mother during pregnancy reduces the REM sleep of the baby.
- Alcohol is also absorbed in the mother’s milk and will affect the newborn during **breastfeeding**.

Childhood sleep

- After three or four months, the baby starts to master the 24h clock that controls the circadian rhythm.
- By the one-year milestone, the baby will have regular night sleep with several naps during the day.
- The balance between NREM and REM declines from **50/50** in six-month-old infants to 80/20 in adulthood.

Sleep and adolescence

- The **NREM sleeps during adolescence** helps the brain to **transition into adulthood** with better **cognitive skills, reasoning, and critical thinking**.
- **Teenagers** have a different circadian rhythm, they have **peak wakefulness at 9 p.m.**
- Parents asking them to sleep at 10p.m is the equivalent of telling you to sleep at 7 p.m.
- Parents and modern society don’t understand that teenagers have a different biological need for sleep.

Sleep in midlife and old age

- Older adults **need less sleep is a myth**.

- Adults have reduced quantity/quality of sleep, reduced sleep efficiency, and **disrupted timing** of sleep.
- With a **weakened bladder**, adults visit the bathroom more frequently at night, their sleep is **fragmented** and less efficient.
- Taking **medications** affects also the quality of sleep.
- Their circadian timing changes to earlier bedtimes with an earlier evening peak of melatonin.
- **Dozing** has damaging consequences for older adults. The dozing disrupts their natural circadian timing. They have difficulty falling asleep in the earlier evening and wake up early with sleep debt.
- As we get older, the **brain deteriorates**. The deep-sleep-generation regions deteriorate the most and have a connection with the loss of deep NREM sleep.
- **Loss and poor memory** are interrelated with poor sleep.
- **Restoring quality sleep** in the elderly could reduce Alzheimer's, diabetes, depression, stroke, and chronic pain.
- Stimulating the brain with an electrical pulse can amplify the quality of deep brainwaves.

Part 2 Why Should You Sleep?

Chapter 6 Your Mother and Shakespeare Knew: The Benefits of Sleep for the Brain

Sleep for the brain

- Light NREM sleep, deep NREM sleep, and REM sleep have their importance and **different roles**.

Sleep-the-night-before learning

- Sleeping before learning refreshed our ability to **make new memories**.
- **Fact-based information** is stored in the **short-term** reservoir of the brain called the **hippocampus**.
- Similar to a USB memory stick, it has a **limited storage capacity**.
- Sleep with **light NREM** moves the memories into the long-term storage vault of the **cortex** and replenishes our learning ability.

Sleep-the-night-after learning

- Sleeping after learning consolidates the information in our brain.
- **Deep REM sleep** (early in the night) moves the information to the neocortex for **long-term memory**.
- Sleep maintains memories and salvages those that appeared to have been lost soon after learning.
- A test showed that rocking a bed gently during NREM sleep boosted the quality of slow brainwaves. Rocking a baby helps to induce deep sleep.

Sleep to forget?

- NREM sleep can make us **forget unnecessary information**.
- We can actively decide what fact-based information needs to be remembered or forgotten.

Sleep for other types of memory

- **“Practice, with sleep, makes perfect”**. Your brain continues to improve skill memories in the absence of further practice.
- **Motor skills** such as piano and sport can be **improved after a sleep** (stage 2 NREM) by automating the movement routines, making them effortless.
- **Sleep** reduces the risk of physical injuries for athletes and **speeds up recovery**.

Sleep for creativity

- Sleep connects ideas during REM sleep and enhances creativity.

Chapter 7 Too Extreme for the *Guinness Book of World Records*: Sleep Deprivation and the Brain

Pay attention

- Sleep deprivation causes a **loss of concentration**.
- Drivers may fall asleep for 2 seconds (**micro sleep**) because of extreme fatigue and cause a car accident.
- During a **microsleep**, the brain **loses awareness** of the outside world. The driver stops reacting altogether.
- David Dinges at the University of Pennsylvania made some tests on sleep deprivation.
- Participants had to press a button in response to a light that appears on a screen to measure their **reaction time**.
- **A few hours of sleep deprivation** per day for a few days have the same negative consequences as no sleep at all with an increase of **missed response by over 400%**.
- Six hours of sleep (two hours of deprivation) for ten days have the same effect as twenty-four hours straight without sleep.

You do not know how sleep-deprived you are when you are sleep-deprived

- Sleep-deprived individuals are **unable to correctly estimate** their degree of performance disability.
- Sleep deprivation of five hours (being up from 7 a.m. to 2 a.m.) has the same effect on performance as being drunk to the legal driving limit.
- Operating on less than five hours of sleep, your risk of a car crash increases threefold.
- Combining **alcohol and sleep deprivation** have a **multiplicative negative effect** on performance.
- The brain requires more than **seven hours of sleep** each night to maintain cognitive performance.

Can naps help?

- **Power naps** momentarily increase basic concentration but **don't replace the need for sleep**.
- Less than **1% of the population** have a genetic anomaly that confers them to **resilience on sleep-deprivation** and can maintain cognitive performance with six hours of sleep.

Emotional irrationality?

- When sleep-deprived, the amygdala shows a 60% amplification in **emotional reactivity**.
- With a lack of sleep, the cortex (rationality) has **less inhibitory control** over our amygdala (emotion).
- The emotions (positive and negative) swing excessively to **both extremes**.
- Sleep loss and mental illness are two-way streets of interaction. Mental illness affects sleep and sleep deprivation affects mental health.

Tired and forgetful?

- The **school system** incites the students to study for the exams and get sleep deprivation.
- Sleep is needed before and after learning to **consolidate the information**.

Sleep and Alzheimer's disease

- **Alzheimer's disease** attacks the neuron in the frontal lobe, which is the region that generates deep NREM sleep.
- When we sleep, the **cerebrospinal fluid** cleans up the poisonous Alzheimer-related protein accumulated in the brain.
- When sleep is treated for the middle and older age adults, the rate of **cognitive decline** slowed and Alzheimer's disease is delayed by five to ten years.

Chapter 8 Cancer, Heart Attacks, and a Shorter Life: Sleep Deprivation and the Body

Sleep Loss and the cardiovascular system

- Sleeping less than six hours increases the risk of **heart attack by 400%**.
- The **sympathetic nervous system** is overactive and triggers a sustained speed of cardiac beating with an increase in **blood pressure**.
- At the same time, the stress hormone called **cortisol** blocks the growth hormone and stops healing your blood vessels.
- Normally, during deep NREM sleep, the brain calms the sympathetic nervous system and averts hypertension and stroke.

Diabetes

- By sleeping 4 hours per night for six nights, the participants were **40% less effective** at absorbing a standard dose of glucose.
- They would be considered as being **pre-diabetic**.
- In a sleep-deprived state, the cells became **less receptive to insulin**.
- Sleep deprivation is a major contributor to the escalation of type 2 diabetes.

Weight gain and obesity

- Short sleep **increases weight gain and obesity**.
- Two hormones regulate appetite: **leptin** signals a sense of feeling full, and **ghrelin** triggers a sensation of hunger.
- Lack of sleep decreases leptin and increases ghrelin, the individual feels hungry and is not satisfied by food.
- Not only do they eat more but they also choose **higher caloric snack foods**.
- When sleep-deprived, the brain **loses control** and sees high-caloric food as more desirable.
- When you don't sleep enough, the release of **cortisol** cultivates "bad bacteria" in your gut and prevents a meaningful absorption of the nutrients.
- During a low-calorie diet, when you are not getting enough sleep, the body loses lean muscle mass instead of fat.

Sleep loss and the reproductive system

- Reduced sleep lower the level of **testosterone**.
- Testosterone stimulates libido, maintains bone density, and builds muscle mass.
- Women with short sleep have a 33% higher rate of **abnormal menstrual cycles** and an 80% more probability to suffer from issues of sub-fertility.
- People who have a good night appear **more attractive**.

Sleep loss and the immune system

- Sleep fights against infection and sickness.
- When you have flu, your brain wants you to go to sleep.
- One single night of reduced sleep **weakens your immune system**.
- Our immune system has **cancer killer cells** (M1 cells) that protect us from cancers.
- Studies show that nighttime shift workers have a higher rate of developing cancer.
- Our over agitated sympathetic nervous system provokes unnecessary **inflammation** that feeds cancers and their spreading.

Sleep loss, genes, and DNA

- Lack of sleep **distorts the genes in your DNA** and disrupts their activity.
- Insufficient sleep attacks the very physical structure of your genetic material and modifies your one transcriptome.

Part 3 How and Why We Dream

Chapter 9 Routinely Psychotic: REM-Sleep Dreaming

Your brain on dreams

- During REM sleep, **visual, motor, emotional, and autobiographical memory** regions of our brain are particularly active, yet the region of our rational thought is deactivated.
- With brain-imaging machines, it is possible to **predict the form and the content of a dream**.

The meaning and content of dreams

- Freud believes that dreams are a manifestation of our repressed desires in a disguised form.
- The **Freudian theory** of the interpretation of dreams is **nonscientific**. Two psychoanalysts will have different interpretations of the same dream.
- **Dreams are not a rewind of a recent experience**. However, between 35% and 55% of emotional themes and concerns people have during the day resurface in their dreams.

Chapter 10 Dreaming as Overnight Therapy

Dreaming - the soothing balm

- Dreaming during REM sleep is necessary and has benefits on our emotional and mental health.
- **Noradrenaline** is a stress-related chemical. It is completely shut off during REM sleep.
- REM sleep **removes the emotional charge** from our memory so we can remember our past experiences without these stressful emotions.
- People who have post-traumatic stress disorder (PTSD) suffer reoccurring nightmares. Despite the dreams during REM sleep, they don't heal from their traumatic past.
- It is only when the noradrenaline level is low that dreaming has its **healing effect**.

Dreaming to decode waking experiences

- The brain of a fully rested person with quality REM sleep decodes and **distinguishes emotions** on people's faces with high accuracy.
- Without a night of good quality sleep, the brain has a default **fear bias** and loses its accuracy in reading people's facial expressions.
- People working during the **night shift** such as policemen and doctors may take **inappropriate decisions**.

Chapter 11 Dream Creativity and Dream Control

Dreaming: the creative incubator

- During REM sleep, our brain **connects ideas**.
- Dmitri Mendeleev got the idea of the periodic table during a dream.

REM-sleep fuzzy logic

- Participants of an experiment were faster to find the answers to anagrams when they wakened up during REM sleep.
- They were much slower when wakened up during NREM sleep.
- **During REM sleep**, the brain is **not logical** and connects very distant, nonobvious ideas.

Memory melding in the furnace of dreams

- **Knowledge** (retention of individual facts) is different from **wisdom** (knowing what they all mean when you fit them together).
- **Computers** can store individual files with precision but **lack creative combinations**.

Code cracking and problem-solving

- REM sleep is capable of creating **abstract knowledge**.
- Infants can abstract grammatical rules after sleeping.

- The problem-solving benefit of dream sleep is universal (sleep on a problem).

Function follows form - dream content matters

- During an experiment, participants were asked to find the exit of a virtual reality maze with some unique objects to act as anchor points at specific locations.
- Those who slept and dreamt about the elements of the maze found their way faster than those who had not slept or who didn't dream about the elements of the maze.

Controlling your dreams - lucidity

- 20% of the population can gain control of their dream and decide what to dream about.
- Scientists took MRI pictures of their brains when they were voluntarily moving their left and right hands in their dreams to tell that they were in control.
- Maybe this skill is the next iteration of Homo sapiens' evolution.

Part 4 From Sleeping Pills to Society Transformed

Chapter 12 Things That Go Bump in the Night: Sleep Disorders and Death Caused by No Sleep

Somnambulism

- The person is in deep NREM sleep without dreams but his body is awakened.
- Children have more sleepwalking or sleep talking because they have a greater amount of deep NREM sleep.
- In 1987, Kenneth Parks murdered his parents-in-law during his sleepwalking.
- Somnambulism episodes are benign.

Insomnia

- Insomnia is suffering from an inadequate ability to generate sleep, despite allowing oneself the adequate opportunity to get sleep.
- **Sleep onset insomnia:** difficulty falling asleep.
- **Maintenance insomnia:** difficulty staying asleep.
- In America, one out of every nine people has chronic insomnia.
- For some people, insomnia is caused by genetics.
- The two most common triggers of chronic insomnia are psychological: **emotional concerns** (worry), and **emotional distress** (anxiety).
- The sympathetic nervous system is overactive and increases brain activation, cortisol, adrenaline, and noradrenaline.
- Body temperature and heart rate are higher.
- They have lower quality deep NREM sleep and fragmented REM sleep. Even if they fall asleep, they don't feel refreshed the next morning.

Narcolepsy

- Narcolepsy is a **neurological disorder** in the brain. It comes from a gene mutation and is not inherited.
- The three core symptoms are **excessive daytime sleepiness, sleep paralysis, and cataplexy**.
- Sleepiness is equivalent to staying awake for 3 days straight.
- When he wakes up, the person is unable to speak or move.
- **Cataplexy** is the immediate loss of muscle tone, resulting in a total body collapse. They have the **body paralysis** of REM sleep (muscle atonia) while being awake.
- **Orexin** is the neurotransmitter that pushes the on/off switch of sleep.
- The narcoleptic brain lacks orexin and has a reduced number of receptors.

Fatal familial insomnia

- Fatal familial insomnia is the **inability to sleep at all**.
- The person loses mental faculties and motor skills and passes away after 6 to 10 months without sleep.

- A genetic defect produces a protein that destroys the thalamus. The person is unable to switch off his conscious perception of the outside world.

Sleep deprivation vs. food deprivation

- In 1983, an experiment at the University of Chicago prevented some rats from sleeping, they die after 15 days on average without sleep.
- Despite eating more than sleep-rested rats, they lost body mass during the study. They increased their metabolic rate to warm their body and brain up.
- Their immune system and organs deteriorated and they got infections and other complications.

No, wait - you only need 6.75 hours of sleep!

- The hunter-gatherer tribe Tsimané in South America slept 6 hours in the summer and 7.2 hours in the winter.
- They give themselves a **7 to 8.5-hour sleep opportunity** each night.
- In our modern society, we give ourselves 5 to 6.5 hours of sleep opportunity.
- As food is scarce, they spend more time foraging and are in a state of lower-level starvation. They still need more than 7 hours of sleep to stay healthy but they spend more awake time finding food.

Is sleeping nine hours a night too much?

- People with infections and cancers sleep longer to fight the disease.
- No biological mechanisms have shown that sleep is harmful.
- Similar to food, water, and oxygen, too much of them can harm the body.
- In humans, the balance of wakefulness is around 16 hours and around 8 hours of sleep.

Chapter 13 iPads, Factory Whistles, and Nightcaps: What's Stopping You from Sleeping?

The dark side of modern light

- Homo sapiens were used to sleeping soon after the sunset.
- With the invention of gas and oil lamps and then the light bulb, **man-made light** changed our sleep patterns.
- The loss of daylight was normally the trigger of the release of **melatonin** that signals to our brain that it was time for bed.
- The **artificial light** fools our suprachiasmatic nucleus into believing the sun has not yet set and delays the release of melatonin.
- The light reduces our sleep opportunities and REM sleep.
- LED-powered laptop screens and iPad with blue light-emitting diodes have twice the harmful impact on nighttime melatonin suppression than the warm yellow light.

Turning down the nightcap-alcohol

- **Alcohol is a sedative** that immobilizes the prefrontal cortex, controlling our impulses and restraining our behavior. It makes people more social.
- With more time, alcohol sedates the other parts of the brain and puts you out of wakefulness.
- Alcohol-infused sleep is **not restorative** and **suppresses REM sleep**.
- The sleep is not continuous with several awakenings.
- While the body is metabolizing alcohol, the by-product chemicals called aldehydes and ketones block the ability to generate REM sleep.
- Alcohol also **disrupts memorization**.

Get the nighttime chills

- A **drop of 1°C** of your core temperature, in parallel with the fading light, increases the surge of melatonin.
- Warm hands and feet help your body to cool and induce faster sleep.
- Splashing water on the face dissipates heat and also cools your body.
- A warm bath dilates blood vessels and helps lower your core body temperature for a faster sleep with an **increase of 15% of deep NREM sleep**.
- Sleeping in a **cooler room** is another technic to improve sleep.

An alarming fact

- **Alarm clocks** are a very unnatural and **intrusive** way of waking up.
- Snoozing is repeatedly harming our cardiovascular system and increasing our blood pressure.
- Walking up at the same time every day helps to maintain a stable sleep schedule.

Chapter 14 Hurting and Helping Your Sleep: Pills vs. Therapy

Should you take two of these before bed?

- Sleeping pills **sedate the receptors** in your brain into sleep.
- Sleep induced by sleeping pills lacks the largest and deepest brainwaves.
- The unwanted side effects are grogginess, forgetfulness, and slow reaction time.
- This drug is **addictive** and creates dependency. After stopping, the person suffers a **rebound in insomnia**.
- Compared to a placebo, sleeping pills slightly improve falling asleep time.

Sleeping pills - the bad, the bad, and the ugly

- A study on animals showed that taking sleeping pills causes a **50% weakening (unwiring) of the brain-cell connections**.
- Taking pills may **reduce memory**.
- Dr. Daniel Kripke at the University of California discovered that those who take sleeping pills have a 4.6 times more chance to die compared to those who didn't take sleeping pills during a two-and-a-half-year window study.
- Those who take a sleeping pill have a higher-than-normal rate of **infection**.
- The other causes of death are fatal car accidents, falls at night, heart disease, and stroke.
- In the same study, those who take a sleeping pill were **30% to 40% more likely to develop cancer**.
- Maybe their illness before taking the pills is the cause of their death.
- Pharmaceutical companies should be transparent and inform the patients of the risks.

Don't take two of these, instead try these

- Before taking pills, the **non-pharmacological method** for improving sleep is:
 1. Establish a regular bedtime and wake-up time
 2. Go to bed only when you feel sleepy, and avoid sleeping early/mid-evenings
 3. Don't lie in the bed when you cannot fall asleep, do a relaxing activity then come back to sleep when sleepy.
 4. Avoid daytime napping if you have difficulty sleeping at night.
 5. Reduce stressful thoughts.
 6. Remove clocks preventing clock-watching anxiety.
- Limiting only to 6 hours of sleep seems paradoxical. The idea is to encourage the patient to regain his confidence in being able to self-generate sleep.
- Restricting sleeping during the daytime builds up **adenosine** to pressure your brain to fall asleep faster at night.

General good sleep practices

- **Physical activities** increase deep NREM sleep.
- Participants **fall asleep faster** and wake up fewer times across the night.
- Good sleep improves physical exercise performance.
- One should avoid doing a physical activity before sleep. High metabolic rate and high body temperature impact negatively your capacity to fall asleep.
- Eating a high carbohydrate, low-fat diet lowers deep NREM sleep but increases REM sleep relative to a two-day diet low in carbohydrates and high in fat.
- No consistent studies are showing a clear association between specific food and sleep.

Chapter 15 Sleep and Society: What Medicine and Education Are Doing Wrong; What Google and NASA Are Doing Right

Sleep in the workplace

- Sleep-deprived individuals are **less productive and less innovative**.
- Insufficient sleep, at the level of a nation, is equivalent to a loss of 2% of GDP.
- Lack of sleep hurts creativity, motivation, effort, efficiency, and intelligence.
- Sleep-deprived workers are unaware of their **poorer performance** and are more likely to lie.
- They also tend to slack off in group work and hide behind the team.
- An under-slept manager is perceived as **less charismatic**.
- More and more companies such as Google and Nike understand the importance of sleep and allow napping during work hours.

The inhumane use of sleep loss in society

- Depriving people of sleep is a **torture technic** used in the military to collect information.
- This technic is not a good idea because the person will have difficulty recalling a memory, his logical thought will be deficient and he will tend to be dishonest.
- The other reason to abolish sleep deprivation is the permanent mental harm with a higher rate of suicidal thoughts and attempts by the prisoners.

Sleep and education

- Starting school at 8 a.m. is **too early** for children and teenagers. Their brain is still developing, and a **lack of REM sleep** may cause mental illnesses such as depression, anxiety, and suicidality.
- A study in the 1960s shows that people deprived of REM sleep (NREM sleep is intact) were diagnosed with anxiety, depression, and schizophrenia after three days.
- REM sleep occurs in the final hours of sleep that we strip from our children each when they wake up for school.
- Better sleep has a positive impact on memory and mood.
- The school of Edina, Minnesota shifted from 7:25 to 8:30 and saw a rise in the results of the Math SAT from 684 to 739 the year after.
- Traffic accidents also plummeted. Parents driving their children to school got fewer accidents.
- Children from **low-income** families take the bus to go to school and have **shorter sleep** compared to families who drive their children to school. This disadvantage perpetuates a vicious cycle.
- Unfortunately, change in the education system is slow. School starts always early to free the parents who have to go to work very early.
- Some children who have the symptoms of **ADHD** (attention deficit hyperactivity disorder) may not need medication but simply more sleep.

Sleep and health care

- Residents working a **30-hour straight shift** at the hospital commit 36% more serious **medical errors** compared with those working 16 hours or less.
- Medical errors are the third cause of death in the USA after heart attacks and cancer.
- After finishing their shift, their chance of being involved in a car accident increases by 168% because of fatigue.
- Medical programs in the UK and Sweden with **16-hour shifts** rank among the top ten countries for medical practice health outcomes while the US institutes rank between eighteen and thirty-second. They have 400% fewer diagnostic errors.

Chapter 16 A New Vision for Sleep in the Twenty-First Century

Individual transformation

- We can use technology to help us to sleep.
- **Devices** can track our circadian rhythm and automatically calibrate the lighting and temperature with machine-learning algorithms.
- We can also use LED bulbs that turn yellow at night less harmful to melatonin.
- The advantage of these technologies is that it is **automatic** and doesn't need us to change our habits.
- Showing personal data helps to build and **reinforce healthy habits** (hours of sleep per night, food intake, temperature).
- Another approach is **predictalytics**. With data and statistics, the algorithm can predict your health for you to adjust your behavior.

Educational change

- Children don't receive any instruction on sleep at school.
- **Raising sleep awareness** through simple education modules could have a huge positive impact on health and the quality of life.

Organizational change

- Companies can incentive sleep to boost performance and happiness at work.
- **Flexible work shifts** can accommodate the morning larks and the night owls and avoid rush-hour traffic.
- In a hospital, patients have a hard time sleeping. They are in an unfamiliar environment, disturbed by the buzzing and alarms from equipment.
- Additionally, checkups are ill-timed while the patient is napping or in the early morning when he is not awakened yet.
- Improving sleep will not only boost their immune system but also reduce drug intake.

Public policy and societal change

- Governments can do **public campaigns** to educate the population about sleep.
- Drowsy driving could be prosecuted.
- Health insurance could provide financial credit to those who have a good sleep credit score.

Conclusion: To Sleep or Not to Sleep

- Human beings evolved to sleep but industrialization changed our habits for the worse.
- Sleep deprivation reduces our quality of life, productivity, safety, and life expectancy.
- A **cultural shift** must occur for us to appreciate the importance of sleep and stop confusing sleep with laziness.