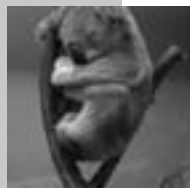


THE ABSOLUTE ESSENTIALS OF SLEEP KNOWLEDGE



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A Note From the Author:

The pure researcher almost never looks back. When a research position requires some teaching, it is then necessary to organize and present the results of research. I have certainly reached a point in my career where research is becoming a smaller and smaller fraction of my daily pursuits.

In recent years, I have been increasingly troubled by the failure of somnology and sleep disorders to achieve mainstream status. A consequence of this failure is that teaching about sleep is still largely absent from the required educational curricula of the grades, colleges, and even graduate schools and training programs. The recent excellent *Institute of Medicine* report titled “Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem” emphasizes and validates the current need *vis a vis* the educational system but focuses more on medical education.

In 1999, with the help of Mr. Christopher Vaughn, I produced a book for the general public titled “The Promise of Sleep.” (I fought like a tiger to call it “The Promise and Peril of Sleep,” but the publisher was adamant that negativity could not be countenanced.) I quickly learned that bookstore tours are a great waste of time particularly for a busy professor. However, for one local appearance (Kepler’s Bookstore in 2000), I went to the trouble of advertising in a local newspaper. It was a very provocative ad and 380 individuals attended my appearance (prior average: 15-20 attendees). My conclusion rightly or wrongly was that this record crowd happened to have a curiosity and excitement about what they would learn because of the advertisement.

As I autographed copies of my 400+ page book, by far the most common comment was, “Gee, it’s big.” Since that time, one effort I have pursued with great diligence is boiling down sleep knowledge to the “absolute essentials” of the sleep facts that every man, woman, and child on the planet should know and understand. The present material is one result of my efforts - a hugely abridged and slightly revised edition of the original “Promise of Sleep.” It is small enough to be widely distributed at zero or very little cost. I hope the foregoing is an adequate introduction and explanation.

— William C. Dement

June 2006, Stanford University

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I

Long Night's Journey into Day

Every night nearly every person on the planet undergoes an astounding metamorphosis as the slide toward sleep begins. At the moment of sleep, our body is inert and our eyes roll slowly from side to side under our closed eyelids. Later as rapid eye movements begin, our mind enters the dream world. Throughout the night we traverse a broad landscape of dreaming and non-dreaming realms wholly unaware of the world outside. Hours later, as the sun rises or the alarm sounds, we are transported back to waking consciousness.

And we remember almost nothing.

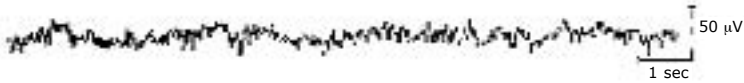
Sleep is a miraculous journey made all the more extraordinary by this one simple fact: We never know we are sleeping while we are asleep. It is impossible to have conscious, experiential knowledge of non-dreaming sleep. In addition, human beings have great difficulty monitoring their own exact "moment of sleep." It is not like a pinprick. Often I ask my students to describe the moment of falling asleep, and invariably they cannot. They can recall lying in bed before sleep and then no more. When we waken we have only a residue of sleepiness, a vague feeling of having slept well or not, and vague fragments of dreams.

Most of us regard sleep as a cessation of all activity, an oblivion we slip into where nothing happens and the brain turns itself off. The truth is completely the opposite. As the muscles relax, the mind shifts, and the brain starts behaving differently. At certain times the sleeping brain actually appears to be more active than it is while awake, burning large quantities of sugar and oxygen as neurons fire rapidly. When dreaming, the mind takes on a different consciousness, inhabits a new world that is as real as the world it experiences when awake.

LONG NIGHT'S JOURNEY INTO DAY

Human Sleep Stages

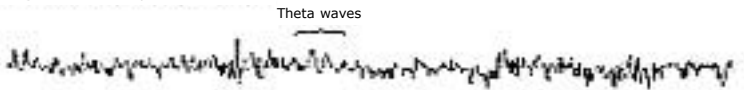
Awake - low voltage - random, fast



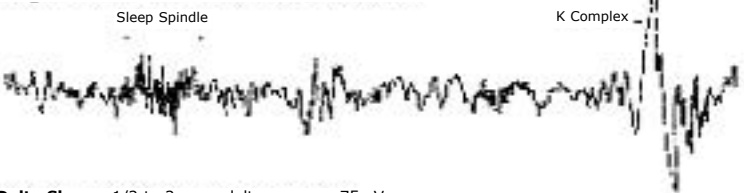
Drowsy - 8 to 12 cps - alpha waves



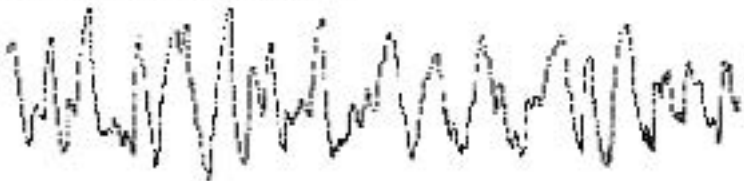
Stage 1 - 3 to 7 cps - theta waves



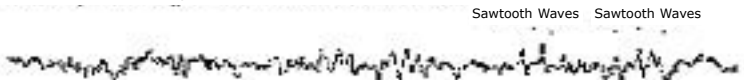
Stage 2 - 12 to 14 cps - sleep spindles and K complexes



Delta Sleep - 1/2 to 2 cps - delta waves > 75 μV



REM SLEEP - low voltage - random, last with sawtooth waves



Human brain wave patterns associated with stages of sleep and wakefulness. In this figure, alpha rhythm is mistakenly labeled drowsy. When individuals are awake and their eyes are open, alpha rhythm is suppressed and low voltage fast patterns are seen. When the eyes are closed, prominent alpha rhythm is seen whether or not an individual is sleepy. The disappearance of alpha rhythm signals the moment of sleep onset and the beginning of NREM Stage I. In humans, NREM Stage I is roughly similar to the EEG activity associated with REM sleep. As can be seen, sleep spindles and delta waves are dramatic indicators of NREM sleep stages.

The Definition of Sleep

I define sleep in terms of only two essential features. The first, and by far the most important, is that sleep erects a perceptual wall between the conscious mind and the outside world. Of course, if a sound is loud enough, it can leap over the sensory wall and wake the sleeper. The second defining feature of normal sleep is that it is readily reversible. Even when someone is deeply asleep, sufficiently intense and persistent stimulation will always awaken the sleeper. If not, the person is not asleep, but anesthetized, in coma, or dead.

Sleep is also associated with characteristic electrical changes in the brain, which scientists can measure using machines called **electroencephalographs** (EEGs). In the sleep lab, we attach electrodes to a person's scalp so that brain activity appears as squiggly lines on moving sheets of paper or in recent years on computer screens.



2

Sleep Debt and Sleep Deprivation

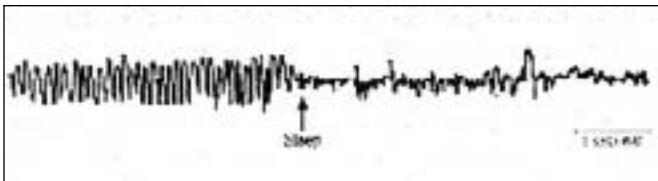
Out of the vast ocean of knowledge about sleep, nothing is more important than the topic of sleep debt. If we can learn to understand sleep indebtedness and manage it, we can greatly improve our everyday life as well as avoid many injuries and premature deaths.

The feeling of being tired and needing sleep is a basic drive of nature, like hunger. If you do not eat enough, you are driven to eat. If you go long enough without food, you can think of nothing else. Once you get food, you eat until you feel full and then you stop. Thus, the subjective responses of hunger and satiation ensure that you fulfill your overall daily requirement for calories. In essentially the same way, your sleep drive keeps an exact tally of accumulated waking hours. Like bricks in a backpack, accumulated sleep drive is a burden that weighs down on you. Every hour that you are awake adds another brick to the backpack: The brain's sleep load increases until you go to sleep, when the load starts to lighten.

In a very real sense all wakefulness is sleep deprivation. As soon as you wake up, the meter starts ticking, calculating how many hours of sleep you will need to pay off the debt that night. Or, to continue the load metaphor, it tallies how many bricks you will have to shed to get back to zero. Generally people need to sleep one hour for every two hours awake, which means that most need around eight hours of sleep a night. Of course, some people need more and some need less, and a few people seem to need a great deal more or less.

How Tired Are You? The Multiple Sleep Latency Test

Conceiving and developing an objective measure of sleepiness was perhaps one of the most important advances in sleep science. We dubbed this objective measure the **Multiple Sleep Latency Test**, or MSLT. This test measures the speed of falling asleep every two hours during the daytime. To minimize the possible horrendous boredom of lying in bed awake for long periods, the maximum duration of a single test is limited to 20 minutes. Subjects go to the bathroom, then we put them to bed in a quiet dark room and tell them to close their eyes, relax, and try to sleep. We remove every source of arousal we can think of so that the strength of the underlying tendency to fall asleep is clearly revealed. Further, we terminate the test and wake the subject immediately after he or she falls asleep. This is so the subject does not get any sleep during the test (which could change their level of sleepiness on subsequent tests). We score the test by noting the number of minutes it took the subject to get to sleep, from 0 to 20. If the person did not fall asleep in 20 minutes, we end the test and give him or her a score of 20. This score denotes maximum alertness at that time of the day. Individual sleep latency measurements are usually taken at 10, 12, 2, 4, and 6 o'clock. The brainwave change at the moment of sleep is illustrated directly below.



Once we had the MSLT test, we investigated the effect of missing two nights' sleep on daytime alertness. Our volunteers' MSLT scores fell close to 0 after the first night—meaning that they fell asleep in less than a minute—and stayed at the same level during repeated tests for the entire 48 hours. With another group of volunteers we decided to vary the amounts of sleep over the course of one night. Some subjects slept 10 hours, some 2 hours, and others slept various amounts in between. This allowed a few volunteers to get as much sleep as they normally needed, others obviously far less. When

we tallied the individual sleep latency scores from the next day's five tests, we found a direct linear relationship between the average amount of sleep amount and the average change in MSLT scores. In other words, the less sleep subjects got, the more rapidly they fell asleep—in direct proportion to the amount of sleep lost. We realized with great excitement that we could accurately measure a person's sleep load in a way that we never could with performance tests.

My colleagues and I then rented a small dormitory and launched the Stanford Summer Sleep Camp in order to provide adequate and comfortable facilities for our round-the-clock studies. After we gathered much more data we decided that a score of 0 to 5 signified an extreme sleep tendency. We often refer informally to the range of MSLT scores from 0 to 5 minutes as the “twilight zone,” because in this range, physical and mental reactions typically are very impaired. A score of 5 to 10 minutes is borderline, while a score of 10 to 15 indicates a manageable sleep debt. A score of 15 to 20 represents excellent alertness.

Sleep Debt: Nature's Loan Shark

Having developed a precise and reliable objective measure of our tendency to fall asleep, the MSLT, we soon made another major discovery: The brain keeps an exact accounting of how much sleep it is owed. In our first study of partial sleep loss, we restricted the sleep of 10 volunteers to exactly 5 hours each night for 7 nights and observed that the tendency to fall asleep increased progressively each successive day. For the first time in the history of sleep research, we discovered that the effect of each successive night of partial sleep loss carried over, and the effect appeared to accumulate in a precisely additive fashion. In other words, the strength of the tendency to fall asleep was progressively greater during each successive day with exactly the same amount of sleep each night. This increased daytime sleep tendency was not reduced without additional sleep. Current evidence suggests that the accumulated lost sleep must be paid back, perhaps even hour for hour.

We use the term “sleep debt” because accumulated lost sleep is like a monetary debt: It must be paid back. Regardless of how rapidly it can be paid back, the important thing is that the size of the

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sleep debt and its dangerous effects are definitely directly related to the total amount of lost sleep. Until proven otherwise, it is reasonable and certainly safer to assume that accumulated lost sleep must be paid back hour for hour. Therefore, if you miss 3 hours one night, you must sleep 11 hours the next night (3 plus your normal 8) in order to feel alert throughout the day.

Your sleep debt may have accumulated in small increments over many days. For example, during a five-day work week where you needed 8 hours each night and instead obtained only 6, you would build up a sleep debt of 10 hours (5 times 2). From this perspective, sleeping in until noon on Saturday is not enough to pay back the 10 lost hours plus your nightly requirement of 8; you would have to sleep until about 5:00 p.m. to balance the sleep ledger. In fact, it is difficult to sleep all day. More likely, you will sleep an extra hour or two and get up feeling better. But the bulk of your sleep debt is still there, demanding to be paid. Later that day you may start feeling the effects of the sleep debt again. And if you lose more sleep time over subsequent nights, you will not just stay tired and sleepy, you will get even worse. As your debt grows, your energy, mood, and cognition will be progressively undermined.

Several groups of sleep researchers have carried out studies in which subjects were awakened every minute or so throughout entire nights, and the next day's alertness was evaluated using the MSLT. The nocturnal awakenings were brief, five to ten seconds, and subjects usually returned to sleep immediately. Although there were usually several hundred interruptions, the cumulative total sleep added up to normal amounts. Nevertheless, daytime sleepiness is markedly increased, as if there had been no sleep at all, or very little. From these results we may conclude that the restorative value of sleep is severely curtailed if sleep periods are not allowed to continue for at least several minutes.

In one study, we tested a number of Stanford students, allowing a baseline normal amount of sleep (8 hours a day) and carefully measuring their sleep tendency day to day with the MSLT. Nearly all of the students appeared to be pathologically sleepy! The explanation finally became obvious. The students' daily sleep requirement was more than eight hours. To prove this, we did studies where we extended their nightly hours in bed to ten, and over several days, the MSLT score steadily improved.

Despite the fact that “sleep debt” has entered common parlance, many people do not fully understand the concept. Again and again I hear people complain that they sleep a full night, even an extra hour or so, and still feel just as tired and sleepy or even sleepier than before. “Well,” they think, “I must be sleepy because I am sleeping too much.”

Arousal: The Mask of Sleep Debt

Because the alertness-sleepiness continuum is a complex function of sleep debt on the one hand and biological alerting and environmental stimulation on the other, we are generally very bad judges of our sleep tendency. In summary, how likely we are to fall asleep is the combination of two opposing forces: our sleep load minus our level of alerting. We may be so excited or stressed by external stimulation that we do not perceive a huge sleep debt.

Uncovering Sleep Debt

We can get an idea of how much sleep debt the average person carries around from describing two specific experiments. The first of these experiments was carried out at the United States Naval Hospital in Bethesda, Maryland. At the time, there was no idea whatsoever about sleep debt, but there was a great deal of interest in the possibility that sensory deprivation might cause disorientation, hallucinations, and psychosis. To test this hypothesis, the naval hospital investigators required subjects to stay alone inside silent, dark cubicles 24 hours a day for one entire week.

With absolutely nothing to do, the group slept a great deal on the first day—averaging more than 16 hours of sleep time out of 24. A few slept 20 hours. Thereafter, their average amount of sleep decreased on each successive day. By the final day, in spite of the complete absence of environmental stimulation, the subjects were able to sleep only an average of about 8 hours. But prior to this, they obtained a total of over 25 hours of sleep more than 8 hours per day. This 25 hours would be about the amount of sleep debt they carried when they entered the study.

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A few years later, psychiatrist Thomas Wehr and his colleagues at the National Institutes of Health in Bethesda, Maryland, put volunteers on a regimen of 14 consecutive hours of in bed per day for six weeks and monitored how their mood and feelings changed over that time. Two volunteers stayed on this schedule for 14 weeks.

The volunteers first spent 8 hours in bed per night for one week. Then they began spending 14 hours in the dark, in bed. They were allowed to have a normal day outside the National Institutes of Health (but no naps!) and were required to arrive at the NIH every day at 4:00 p.m. They were then given a short test of their mood and wired with temperature and sleep probes. At 5:00 p.m. they went to their separate bedrooms—windowless chambers without lights. They could not read, listen to music, or do any other activity that might keep them awake artificially. Like the navy subjects, they could only lie in bed in the dark. At 7:00 a.m., 14 hours later, they rose and were brought out of their rooms, unwired, given another psychological test, and at about 8:00 a.m. allowed back out into the wide world. But for only eight hours.

You might think that this sort of existence would drive people crazy, but like those in the navy experiment, they slept a lot at first, an average of more than 12 hours per day. But by the fourth week they had settled down to a steady-state nightly average of 8 hours and 15 minutes of sleep. The steady state amount of sleep was a little more for some people; for others some a little less. The longest sleeper regularly got about 9 hours of sleep, and the shortest sleeper got about 7.5 hours of sleep.

As in the navy study, my interpretation of the results is that the subjects were carrying sizable sleep debts when the baseline week began, and they may actually have accumulated a little more sleep debt during the baseline week. When given extra hours of darkness and deprived of stimulation that normally would override sleep debt, they had nothing to do but pay off that debt. Then, as the sleep debt was worked off, they slept less and less, even though they had the opportunity to keep sleeping long hours. Eventually subjects in both experiments adopted a steady state of close to 8 hours of sleep per day, which probably represented their actual daily sleep requirement. In Wehr's experiment, volunteers who seemed perfectly normal when they entered the test worked off an average of about 30 hours

of sleep debt—the equivalent of 2 lost hours a day for 2 weeks! The subjects' mood and level of energy also improved tremendously over the course of the NIH study. The crucial variable for mood was not the amount of light but the size of each person's sleep debt.

Potentially one of the most important consequences of excessive sleep debt is highlighted in research carried out by Tom Roth and his colleagues. In the experiment mentioned below, Roth and crew tested the cognitive performance of some of his subjects who had scored near zero on the MSLT. Then they required the subjects to spend 10 hours in bed for seven consecutive nights in order to pay off their debts. Afterward the subjects were retested and their mental performance improved. The results showed a direct correlation between the quality of mental performance and the level of sleep debt. What this means to me is that millions of us are living a less than optimal life and performing at a less than optimal level, impaired by an amount of sleep debt that we are not even aware we carry. The implications for productivity and performance in every area of life and every component of society are staggering.

Fatal Fatigue: Alcohol and Sleep Debt

But all those interested in traffic safety and all those who wish to have a long life as well, must take note. When a crash is attributed to alcohol, the real culprit, or at least a co-conspirator, is very often sleep deprivation. In studies that are crucially important, the powerful interaction between sleep and alcohol was revealed by another study at Henry Ford Hospital Sleep Disorders Center in Detroit. A group of volunteers slept 10 hours a night for one week, 8 hours a night during a separate week, and on a third schedule simulated a social weekend by getting 5 hours of sleep for 2 nights. In the morning after completing each schedule, all of the volunteers were given either a low dose of alcohol or a placebo. Then their degree of impaired alertness was evaluated utilizing the MSLT and performance tests. When the subjects were given the low dose of alcohol after the 8-hour schedule, they became slightly more impaired than when given placebo. After the schedule of 2 nights with little sleep, the exact same dose of alcohol the next morning made them severely impaired and sleepy, barely able to stay awake. However, the exact same dose of alcohol after

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10 hours of sleep every night for a week had no discernible effect. In other words, alcohol may not be a potent sedative by itself, but it becomes very sedating when paired with sleep debt.

The implications of this intervention are far-reaching. People are well aware of the dangers of drinking and driving, but they do not know that a large sleep debt and even a small amount of alcohol can create a “fatal fatigue.” People can be just fine driving after a single drink one day (when they have little sleep debt), yet be a hazard to themselves and others if they have that same drink on a day in which they have a large sleep debt.



3

The Biological Clock

Over millions of years, our bodies have developed a remarkably precise biological clock to regulate sleeping and waking. The clock is an internal chronometer that marks time by basic molecular mechanisms that scientists have almost completely unraveled. Since before the birth of our species, the daily rising and setting of the sun have shaped this molecular timepiece, until the clock itself has become a tiny mirror of the celestial clock.

By far the most important function of this biological clock is that it is a major determinant of our daily cycle of sleep and wakefulness. We eat, think, exercise, wake up, and sleep best when we heed its rhythm. Individuals who are out of synchrony with their clocks, such as shift workers who never fully adjust to nighttime work and daytime sleep, under perform both physically and mentally, as study after study has confirmed. For a jet traveler, the alarm just goes off at the wrong time. But unlike your average alarm clock, a traveler cannot turn it off and go back to sleep. Our understanding of both clock-dependent alerting and sleep debt has provided the pillars for a very simple and elegant model of what governs why we are awake during the day and asleep at night; in fact, it can further account for periods of alertness or drowsiness whenever they occur.

The Biological Clock and the Opponent-Process Model

A very important series of observations on the sleep and wakefulness of squirrel monkeys (primates) before and after eliminating their biological clocks was carried out a few years ago. In

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order to minimize the effect of environmental stimulation, the monkeys were studied while they were maintained in constant dim light, sound insulation, constant temperature, and ad-lib food and water. In an absolutely unchanging environment, the normal monkeys behaved as if there were a sunset and sunrise or some sort of night and day schedule. They would wake up and stay awake for 15 to 16 hours, and then go to sleep for 8 to 9 hours. The inescapable conclusion is that an internal pacemaker or biological clock controls this profound daily oscillation. This continuing cycle manifested in constant conditions is therefore called free running and it belongs to a class of rhythms or cycles that have a period approximating 24 hours. Such cycles are called circadian rhythms.

After uninterruptedly recording brain waves and other variables for about a week, we put the monkeys' biological clocks permanently out of action by means of a special technique. When the same continuous recordings were repeated, we saw a profound change. Instead of remaining awake for hours and then sleeping for hours, the monkeys were continually falling asleep. Their periods of wakefulness became very short and evenly distributed throughout the entire observation period. Over a number of days of continuous brain-wave recording, it was absolutely clear that the dramatic circadian rhythm of sustained sleep followed by sustained wakefulness had completely disappeared.

This result meant not only that the biological clock is not necessary for sleep but that it *normally promotes wakefulness and actively opposes sleep*. In fact, we could conclude that the only role played by the biological clock in our daily cycle is to promote and maintain alert wakefulness. Furthermore, this role is expressed only at certain times. We have designated this powerful process as **clock-dependent alerting**. At certain times each day, our brains are powerfully stimulated by our biological clocks. At the other times, the stimulation subsides or is turned off.

As we have learned already, the brain in every human being possesses a process that is active 24 hours a day. Its sole function is to induce and maintain sleep. It is a homeostatic process. This means that when an individual obtains less sleep than the needed amount, the homeostatic process increases the tendency to fall asleep; conversely, when extra sleep is obtained, the homeostatic process

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decreases the tendency to fall asleep. This ensures that an individual averages the right amount of sleep on each day over time. In its own way, this process appears to have a precision similar to the biological clock in terms of keeping a precise record of the accumulated sleep debt. Theoretically, since all wakefulness is sleep deprivation, sleep debt can be zero for only a very brief time. The biological sleep drive that causes us to fall asleep and to remain asleep through the night is continuously active, even when we are awake. In fact, when we are awake, the homeostatic sleep drive is steadily increasing. Opposing this sleep tendency is the alerting action of the biological clock. In contrast to sleep homeostasis, the process in our brain that fosters wakefulness and sustained alertness is not active continuously.

We now postulate that daytime clock-dependent alerting in humans occurs in two waves, one in the morning (starting when you wake up) and the other late in the day (starting typically in the late afternoon, around 4:00 or 5:00 p.m.). We further postulate that clock-dependent alerting is substantially stronger during the evening period than in the morning period. This is a beautiful mechanism, because as sleep debt accumulates during the day, a stronger stimulation is required to keep us awake and alert through the afternoon and evening hours.

In the early afternoon, between the two peaks of heightened clock-dependent alerting, the clock slacks off in its efforts to keep us awake. The result is post-prandial drowsiness which most people wrongly attribute to the after effects of eating lunch. In reality, people are only feeling their accumulated sleep debt, unopposed by clock-dependent alerting. Some of us completely “bottom out” during this time. In many cultures, people cope with this early-afternoon dip by retiring immediately after lunch for an afternoon nap.

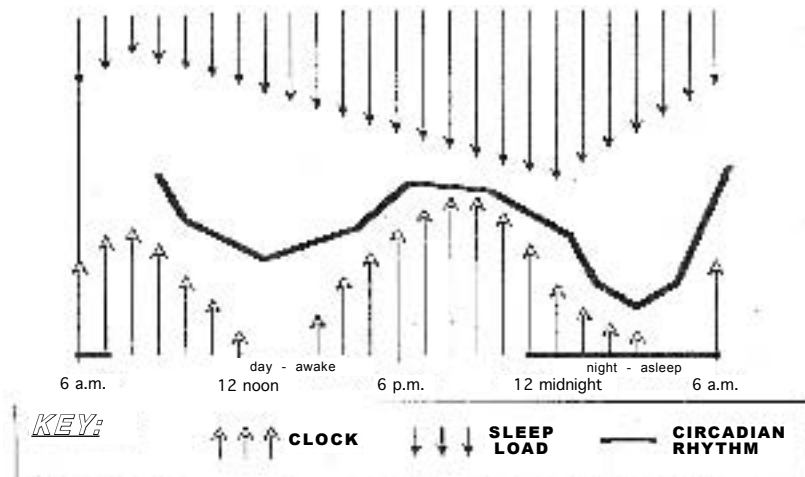
In my opinion, the strongest experimental evidence for the existence of clock-dependent alerting in humans comes from a variant of the Multiple Sleep Latency Test. In the Stanford Summer Sleep Camp, we pushed the envelope and added two additional tests at 8:00 p.m. and 10:00 p.m. We called this approach the **extended MSLT**. Invariably, the sleep latency was longer than previously (alertness level improved over earlier tests done that day) in the 8:00 p.m. test and even longer (alertness most improved) in the 10:00 p.m. test.

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Occasionally subjects were completely unable to fall asleep during the last test.

After centuries of assuming the longer we are awake, the sleepier we will become and the more we will tend to fall asleep, we were confronted with the surprising result that after 12 hours of being awake, the subjects had a *weaker* sleep tendency. Because we now know that there is a strong evening period of clock-dependent alerting, the extended MSLT results are not only perfectly understandable, but they also provide strong confirmation of the role of the biological clock in the opponent-process model.

Phase Response Curve



The opponent process model. This figure is a detailed schematic illustration of the opposing processes that regulate the daily cycle of sleep and wakefulness. Primates and rodents whose biological clock has been eliminated continue to fall asleep normally and show normal sleep. They can also wake normally, and can be kept awake for fairly long periods of time by external stimulation after which they will sleep for longer periods of time. In other words, elimination of the biological clock appears to leave the homeostatic sleep mechanism completely unimpaired. The biological clock independently fosters continuous, alert wakefulness during specific periods of the nycthemeron that are advantageous for the species. The opponent process model includes timed periods of clock dependent alerting opposed by wake-related build up in homeostatic sleep tendency or drive to sleep. The interaction of these processes determines the strength of the sleep latency at any particular moment. External stimulation will also induce waking but unless the stimulation is extraordinarily intense or prolonged, the effect in terms of the 24-hour day is negligible.

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A very important aspect of resetting the biological clock is that the clock can only be reset at certain times. These times are during specific portions of the circadian rhythm. Depending upon the time that the resetting stimulus is delivered (referred to as the phase of the rhythm), the clock will be reset to an earlier time or a later time, and the change will be either larger or smaller. Obviously, clock resetting cannot be done carelessly. It is sufficiently complex that specific individual instructions should be followed. It is important to note that the human biological clock responds to light exposure at night and not in the middle of the day.

In general, light exposure in the evening and into the first part of the nocturnal hours will have an increasing potency in delaying the clock. The typical result might be that the first wake-up signal would occur an hour or so later than normal. At approximately the middle of the night, there is an abrupt shift in the direction of the resetting response such that now light exposure in the latter hours of the night and early morning will advance the clock, so that the wake-up signal it emits will occur earlier than normal.

The clock resetting effect of melatonin is essentially the opposite of light. If melatonin is ingested in the morning, it should delay the biological clock, and if ingested in the evening, it should advance the biological clock. When the resetting sensitivity of the biological clock is systematically tested at a number of different points around the circadian cycle, the result is called a phase-response curve. This curve will show how much of a response to expect depending on the nature of the stimulus, when the stimulus is delivered, and in which species it is delivered.

Clockworks

In 1972, two separate laboratory teams, one headed by Robert Moore and the other by David Zucker, identified the locus of the biological clock deep in the brain in two pinhead-size clusters of nerve cells called the **suprachiasmatic nuclei**, or SCN. There are about 10,000 nerve cells in these tiny clusters which is a very small fraction of the human brain's trillion neurons. The two SCN sit in the midline of the brain, directly above the optic nerves which are the two

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great neural cables carrying electrochemical signals from the eyes to the visual portions of the brain. The SCN uses this position to monitor levels of light entering the eyes and to adjust the rhythmic fluctuations of body temperature, hormone release, and metabolic rate.



4

Insomnia

How Serious a Problem?

The very first dividing line in addressing any problem of insomnia is whether it really bothers you. The problem may be very severe: trouble sleeping every night with only a very small and fitful amount of sleep. Or it may be quite trivial: an hour awake in a strange bedroom before falling asleep, and no insomnia the next night.

What Causes “Transient” Insomnia?

Sleep specialists like to divide insomnia into two categories: **transient** cases lasting only one night to a week or two, and **chronic** cases lasting weeks, months, or years. These are useful categories, but sometimes they are a little too rigid. People often have a few nights of trouble sleeping, then a few nights of good sleep, then more nights of insomnia. The possible manifestations over a long period of time are almost infinite. In my opinion, the most helpful aspect of identifying transient insomnia is that the cause is almost always outside of or independent of the sleep process. Three main circumstances can cause transient insomnia: hyperarousal, rapid time zone or schedule change, and environmental disturbance.

Hyperarousal

In a number of surveys, and in my own personal clinical experience, hyperarousal caused by stress, worry, and/or anxiety is the most frequently mentioned cause of sleeping difficulties, and is

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reported by well over half of all those who have experienced transient insomnia. The degree to which sleep is disturbed is generally a function of the severity and duration of the stressful circumstances.

Time Zone and Schedule Changes

When our circadian rhythms are disrupted by jet lag, shift work, and other major schedule changes, insomnia often results. An individual's clock-dependent alerting is thrown out of synchrony with new light and dark cycles, arousing the body when the "alarm" should be turned off. When people move quickly from one time zone to another or start a new shift, their bodies do not have time to catch up. Although some people may feel better in a day or two, others do not and their body's biological rhythms take a full week or more to catch up to the new time.

Sleep Environment

This should be obvious. Noises from traffic, plumbing, or neighbors partying are often blamed for insomnia. On the other hand, people soon habituate to repeated meaningless noise and tend not to wake up. Personally, I am somewhat skeptical that environmental factors are of overriding importance as direct causes of insomnia. However, I think sensitivity to noise can be magnified by other factors, such as stress or anger. As I suggested, being disturbed by noise is usually transient, but if you feel that the noise is being made maliciously and deliberately to annoy you, it is likely that your sleep will be very disturbed.

Late to Bed or Early to Rise?

Once it is clear that someone's insomnia is persistent, that is, recurring frequently or nearly every night, one of the first things I do is determine if the difficulty is with falling asleep or waking up too early. If you think you have an insomnia problem and it is confined to being unable to fall asleep, it is likely that the insomnia is the result of a circadian rhythm problem. You now know from what I have told you about the biological clock that strong clock-dependent alerting occurs typically in the evening. When the biological clock is alerting

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the brain at a time that you want to schedule your bedtime, you will have sleep-onset insomnia. When evening alerting keeps people up late and it is then difficult for them to get up in the morning, we sometimes call the problem **delayed sleep-phase syndrome**, or DSPS.

The other problem, waking up too early, is often considered to be a hallmark symptom of depression. But the biological clock can run too early as well as too late. If someone has consistent difficulty staying asleep in the morning, we always ask, “Are you sleepy or tired in the evening, and do you fall asleep in front of the TV?” If the answer is yes, this is the mirror image of delayed sleep-phase syndrome, designated as **advanced sleep-phase syndrome**, or ASPS.

For some years now the treatment has been bright light in the morning for DSPS and bright light in the evening for ASPS. The usual prescription is sitting in front of a bank of fluorescent lights for a couple of hours with the light coming in at a 45° angle.

Other Major Causes of Persistent Insomnia

For those who have persistent insomnia that is not due to biological clock problems, a large percentage will find that their insomnia is due to one of three physical causes—restless legs syndrome, gastroesophageal reflux, or fibromyalgia.

Restless Legs Syndrome

A very large number of those people who experience difficulty sleeping on a frequent basis report creepy, crawly feelings in their legs that go away when they move about. These symptoms are invariably indicative of a disorder called **restless legs syndrome** (RLS). The hallmark of this syndrome, uncomfortable and sometimes painful feelings in the legs which create a desire to move them, causes difficulty sleeping. When symptoms occur, victims vigorously flex, stretch, and cross their legs to ease their discomfort. Usually patients prefer to walk about if possible. The feelings are relieved briefly, but return shortly thereafter.

There is a clear tendency for the prevalence to increase with age, but the syndrome may occur in children. There does not appear to be a gender difference. The basic cause of RLS is unknown, but

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it is somewhat more common in patients suffering from iron deficiency/anemia or kidney failure with dialysis.

The prevalence of RLS is estimated to be in the range of 10 to 20 percent. We have studied a primary care population in Moscow, Idaho, and 24 percent of the patients reported unambiguous symptoms of RLS. As with other sleep disorders, none of the RLS patients had been given a diagnosis. Today, failure to diagnose is completely unacceptable because very effective treatments have been developed.

Gastroesophageal Reflux

Sometimes the flow of stomach acid back into the lower esophagus (gastroesophageal reflux) causes sleep to be disturbed. If the acid makes it all the way to our throat and larynx, the sleeper will awaken coughing and choking. However, if the acid flows back only into our lower esophagus, the sleeper will wake up but will not know why. This was demonstrated in experiments in which a drop or two of acid was passed through a tube into the esophagus near the stomach. Even this small amount of acid caused the sleeping subject to wake up even though he did not report feeling heartburn or other sensations.

Heartburn is a very common disorder of waking patients. Gastroesophageal reflux is potentially a much more common cause of insomnia than heretofore assumed, and should always be considered. Medications that block acid secretion are now available without a prescription, and the simple step of not eating a full meal before going to bed will also help. In patients who complain of difficulty sleeping with no apparent reason and occasionally awaken with heartburn, gastroesophageal reflux should definitely be considered as a cause.

Fibromyalgia Syndrome (Fibrositis)

Fibromyalgia is a disorder associated with pain in muscles and tendons, characteristically with points of tenderness in certain typical locations. There is always daytime fatigue and very commonly difficulty falling asleep and staying asleep. It is not always obvious why patients complain about difficulty sleeping. Of course, pain will

disturb sleep. However, when patients with fibrositis syndrome are given the Multiple Sleep Latency Test, their results rarely suggest severe sleep deprivation. The American Fibromyalgia Syndrome Association estimates that there are over 10 million sufferers in the United States.

Insomnia Associated with Psychological, Emotional, and Psychiatric Problems

Frequent or persistent problems sleeping are very commonly associated with depression and other psychiatric problems. When these problems—phobias, anxieties, neuroses, and so on—are not obvious, spotting the true cause of the insomnia becomes more difficult. Generally, these cases are handled by psychiatrists, although most psychiatrists have little expertise in sleep disorders. Not enough outcome data exist to indicate how frequently an insomnia problem clears up if the underlying psychiatric condition is effectively treated.

Disorders Requiring a Sleep Test for Diagnosis

Once all of the aforementioned causes of every night or frequently recurring insomnia are ruled out, there still exist several possible causes that can be identified with certainty only by polysomnographic testing in a sleep disorders clinic (although sometimes careful questioning can elicit clues). Perhaps the most common of these is **periodic limb movement disorder** (PLMD), which, as mentioned earlier, is very frequently associated with restless legs syndrome. Occasionally, PLMD occurs in isolation.

The second cause is **central sleep apnea**, in which breathing simply stops during sleep and is resumed only when a patient awakens. The severity of central sleep apnea is related to the number of times the victim stops breathing during sleep. Snoring can occur but is usually not prominent. Sometimes central and obstructive sleep apnea can occur together (mixed apnea), but in central sleep apnea itself there is no obstruction. There is no truly effective treatment for this condition. Happily, central sleep apnea is rare.

A third diagnosis that can be made only by carrying out a sleep test is called **sleep state misperception**. From the viewpoint of

a sleep specialist, this is a very interesting and perplexing condition which occurs in about 5 percent of insomnia cases. It is diagnosed in patients who complain of persistent insomnia, but when tested show completely normal sleep. Most of these people do not say they have had no sleep whatsoever, but their estimate is a lot less than what actually occurs. The problem of sleep-state misperception can sometimes be resolved by persuading people that their sleep is normal no matter what they think.

Primary Insomnias

At last we are left with two distinct diagnoses that are often lumped together as “primary insomnias.” The first, and by far the most common, is **psychophysiological insomnia**, also called learned insomnia or conditioned insomnia. This is one of the most frequently diagnosed insomnias in sleep clinics. The diagnosis is considered when the patient interview suggests a great deal of anxiety and tension around getting ready for bed and getting ready to go to sleep. Often patients describe getting enough sleep as the greatest struggle in their life. When patients give a history of sleeping better in a strange environment than in their own bedroom, this is usually a good clue to the diagnosis—in the foreign environment, the cues and conditioned signals that create tension are either absent or else greatly reduced.

A clinical diagnosis of psychophysiological insomnia must also include a daytime consequence, usually irritability, anxiety, and depressed mood. Finally, the polysomnogram must show disturbed sleep in terms of a prolonged sleep latency—20 minutes or more—and an abnormal amount of wakefulness during the night.

The second diagnosis is **idiopathic insomnia**, which was originally called childhood-onset insomnia, and refers to a lifelong inability to obtain adequate sleep. It is presumably due to an abnormality in the brain mechanisms that control the sleep-wake system. The exact prevalence is unknown, but the disorder is definitely not common. The crucial feature is the onset at an early age. The presence of daytime symptoms and certain mild neurological signs differentiate this diagnosis from a normal short sleeper.

Treating Primary Insomnias

The primary insomnias are usually difficult to treat. However, there are a variety of general techniques that can be tried to alleviate primary insomnia. These approaches include improving sleep hygiene (which is a good idea for everyone), relaxation techniques, stimulus control, cognitive techniques, and sleep state restriction.

Improving Sleep Hygiene

The simple goal of good sleep hygiene is to do everything possible to foster good sleep at night. Sleep hygiene is mainly a behavioral approach such as avoiding caffeine before bedtime. One of the most important behaviors for healthy sleep is keeping a regular schedule. This helps train your sleep cycle in the same way that running at the same time every morning conditions you to prepare for exercise at that time.

Relaxation Techniques

Relaxation has long been used to fight the body's sleep disruptive physiological arousal. The most widely used technique is called progressive relaxation training. With this method, insomniacs learn to relax systematically, first by tensing and relaxing the feet, then the legs, then the hands, then the arms, and so on. They also concentrate on controlling breathing and think about pleasant sensations. This technique can be very effective in fostering sleep at the beginning of the night and returning to sleep in the middle of the night.

Stimulus Control

One important part of improving our chance to fall asleep is to abolish stimulating activities or thoughts as much as possible as bedtime approaches. Keeping away from things that provoke anxiety before you try to go to sleep may sound obvious, but it is amazing how often people will get themselves excited, upset, anxious, or angry before going to bed. For example, they watch the late news, seeing stories on rape, murder, fatal accidents, and corruption. Other counter productive activities include doing homework, paying bills, or checking e-mail right before going to bed.

Cognitive Techniques

Techniques that engage the mind with some simple, repetitive problems are longtime favorites for battling sleeplessness. The mental attention that these tasks require offers a distraction from thoughts that interfere with sleep. Counting sheep is the classic example. Another method that sometimes works to get the mind off the subject of sleep is, paradoxically, to make staying awake a goal. Trying to stay awake for as long as possible often counteracts the fear of not being able to sleep. Doing so, patients relax enough to let their (usually substantial) sleep debt take over, and they drift off to sleep.

Sleep State Restriction

One of the approaches that I like to use to fight insomnia is called sleep state restriction. I favor this technique for patients who are exaggerating their symptoms or have honest misperceptions about their sleep but cannot accept the possibility that they might be able to sleep normally. I do not want them to feel I am accusing them of lying, and it allows me to avoid a confrontation on this point. If someone comes to me and says, “Doctor, I sleep only four hours a night,” I say, “Okay, I want you to go to bed at 3:00 a.m. and get up at 7:00 a.m.” After sleeping only four hours, the patient usually feels tired and sleepy. Then we add half an hour of sleep every night, until a week later the patient is up to a solid seven and a half hours a night. This technique requires a high degree of commitment by the patient and is not suitable for everyone.

Melatonin (available over the counter)

What we know about melatonin is that it is a hormone secreted by the pineal gland in the brain that tells the body that it is dark outside. For humans, melatonin directs the body to prepare for sleep; for nocturnal animals like rats, its release is a sign to start waking up. Long winter nights lead to higher melatonin levels in the body, and short summer nights lead to lower levels.

The sleep-inducing effect of melatonin works in counterpoint to the alerting effect of light. In very low doses (up to 0.5 milligrams for the average adult), melatonin can shift the phase of the biological clock. Melatonin rises naturally right before falling asleep, and

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ingested melatonin can produce the same sort of surge. Melatonin is most likely to affect the phase of the biological clock when it is synchronized with changing light levels. For example, if you usually cannot get to sleep before 1:00 a.m., you may be able to get to sleep earlier by ingesting melatonin shortly after the sun sets. As noted earlier, taking melatonin at night causes a phase-advance (earlier to bed and earlier to rise), whereas melatonin in the morning induces a phase-delay (later to rise and later to bed).

Treating Insomnia: The Case for Sleeping Pills

The biggest challenge to treating insomnia is persuading doctors and even the patients who have the insomnia that it is a serious problem. In our uninformed society, many doctors and lay people consider insomnia a nuisance condition even less important than the common cold or flu. We now know that insomnia can be a deadly problem predisposing to falling asleep in hazardous situations and which failure to treat will put our own lives at risk as well as the lives of others. New classes of hypnotic medications have been developed that are safer and more effective than any that have come before: Ambien, Sonata, Lunesta, and most recently, Rozerem. To be approved as a medication specifically recommended for insomnia, a candidate **hypnotic** (the name used for sleep-inducing drugs) must pass an incredible array of tests involving many normal volunteers and patients with insomnia. Such tests are very expensive, and it could cost more than \$100 million to evaluate just one compound. These days Ambien is probably the most-prescribed hypnotic in the United States, but the use of others is increasing.

Over-the-Counter Medications

To me, the millions of sleep sufferers who are driven to self-medication are the most eloquent testimony to the under use of prescription hypnotics. Most over-the-counter “sleep aids” have no proven efficacy. The primary ingredient in such sleep medications is usually an antihistamine. Histamine neurons in the brain are related

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to general alertness, firing more frequently when we are most active. Antihistamines may induce sleepiness by damping down the activity of these nerve cells.



Snoring and Sleep Apnea

Sleep apnea is an unrecognized killer, but it is hiding in plain sight. Every night more than 50 million Americans stop breathing. In a stunning evolutionary failure, nature endowed us with throats that tend to collapse during sleep and block air flow but did *not* endow our sleeping brains with the ability to start breathing without waking up. At this breathless moment, the immediate future holds only two possibilities: death, or waking up to breathe. In the worst cases, no air enters the lungs for 40, 50, 60 seconds, or longer. The muscles of the diaphragm struggle harder and harder against the blocked throat, without success. Carbon dioxide builds up in the bloodstream and the level of life-giving oxygen falls precipitously. The skin and lips turn blue. Just when death seems imminent, the sleeper suddenly struggles awake and the tongue and throat muscles tighten, allowing oxygen to flood into the lungs in a series of gasping, snorting breaths. Once oxygen is restored to the blood, the fatal course is reversed. Instead of being alarmed and staying awake, the victim is immediately asleep again. After a few seconds snoring begins—and the cycle starts again, repeating hundreds and hundreds of times a night.

Amazingly, sleep apnea victims typically have no memory of their all-night life-and-death struggle for air. They can awaken hundreds of times in a single night and remember nothing of that torment. It is hard to measure how much real sleep such patients lose, but it is at least a third of their time in bed. And when sleep is interrupted this many times, it has little value in reducing sleep debt. Victims of this midnight strangler may be aware that they have lost their energy and are tired all day, but they never know the reason unless someone they believe tells them what is going on at night and how it is affecting

them.

The tragedy of undiagnosed sleep apnea is especially striking because there are very effective treatments. Although the number of sleep apnea patients treated by all sleep medicine specialists must total hundreds of thousands in the United States and perhaps more than a million people worldwide, we have yet to reach the tens of millions of apnea victims right here in the world's most medically sophisticated nation who continue to suffer without diagnosis or treatment.

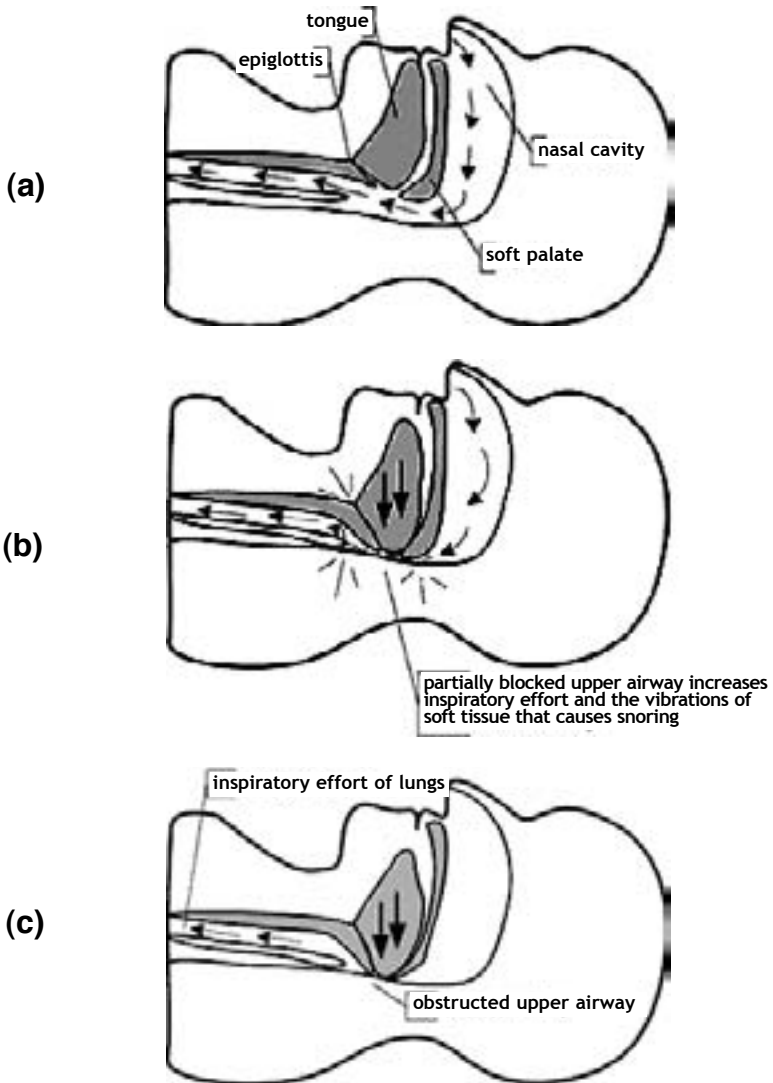
When Snoring Becomes Sleep Apnea

Not everyone who snores has sleep apnea, but in general, the louder the snoring, the more likely it is that the sleeper has apnea. There are really two types of apnea: central sleep apnea and obstructive sleep apnea. Obstructive sleep apnea is by far the more common type. Therefore in the following material, the phrase “sleep apnea” will always mean obstructive sleep apnea.

In obstructive sleep apnea, the walls of the throat are pulled together by the suction created during inspiration (breathing in). When the diaphragm relaxes at the end of the breath, the throat can open passively. Remember that the throat closes at the beginning of inspiration, after most of the air in the lungs has been exhaled. This is why blood-oxygen levels fall faster than they would if you were simply holding your breath. To make things worse, the respiratory cycle continues as the diaphragm makes a tremendous and futile increasing effort to pull air in, and then relaxes and lets a little air out—eventually ratcheting out all the remaining air in the lungs. When air does not get into the lungs, the oxygen levels in the bloodstream begin to fall. In many cases the level of oxygen in the blood falls to dangerous levels. Brain damage is a possible result of such low oxygen levels. Once the apnea victim rouses and begins to breathe, oxygen levels rise—but another kind of stress is initiated. The heart starts pumping madly and blood pressure rises rapidly to alarmingly high levels.

The measure that is used commonly for the clinical definition of sleep apnea and for rating its severity is called the Apnea/

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(a): Schematic drawing illustrating normal breathing during sleep. Airway resistance is low.

(b): Schematic drawing illustrating increased airway resistance. The airway size is reduced, but not completely blocked. This partial blockage increases inspiratory effort and the increased velocity of airflow causes turbulence, which, in turn, causes the soft tissue to vibrate creating the noise known as snoring.

(c): Schematic drawing illustrating a completely obstructed airway.

Hypopnea Index (AHI). An **hypopnea** is when the throat does not quite close entirely, but air flow is reduced sufficiently to lower oxygen and cause an arousal. The AHI score represents the average number of apnea and hypopnea episodes that a patient experiences during an hour of sleep. An AHI of 5 is the lower limit for making a clinical diagnosis of sleep apnea.

Additionally, the danger of apnea stems not only from heart problems and high blood pressure, but also from the incredible sleep debt that apnea sufferers carry around with them since they get almost no continuous sleep at night. People with severe apnea typically carry so much sleep debt that they fall asleep while driving, eating, or talking. People with apnea are much more likely to be involved in auto accidents. Some studies suggest that sleep apnea victims have an accident rate 10 times that of the general population and they have no idea why they are falling asleep behind the wheel.

Finally, the fact that sleep apnea and marked obesity often go hand in hand means that many of the health problems caused by apnea are erroneously attributed to the patient's weight.

There is no question obstructive sleep apnea plays a major role in causing high blood pressure, heart disease, and stroke. We urge people who have high blood pressure, heart disease, or concern about a stroke to ask themselves two questions: Am I tired in the daytime? And have I been told that I snore? If the answers to both questions are yes, checking for the presence of apnea is mandatory, even if the sleep test is nothing more than putting a tape recorder next to the bed at night.

The prevalence of apnea rises as humans get older, probably because all tissue, including tissue in the airway, becomes less firm as we age. Therefore, apnea should be one of the first things doctors consider when elderly patients have problems with sleepiness, high blood pressure, or cognitive problems—but doctors rarely do this.

Treating Sleep Apnea

If the bad news about sleep apnea is that it is widespread, life-threatening, and underdiagnosed, the good news is that it can be safely and effectively treated. Doctors can treat severe apnea in one of two ways: by holding the air passage open mechanically during

sleep, or by enlarging the air passage.

Continuous Positive Airway Pressure

For over two decades, continuous positive airway pressure (CPAP) machines have been the most effective way of treating obstructive sleep apnea. To use the machine, a small, comfortable mask is fitted over the nose, leaving the mouth uncovered. Patients must sleep with their mouth closed, sometimes aided by a chin strap, while the machine gently blows air into the nose at a pressure slightly higher than the surrounding air pressure.

Literally within minutes of achieving the correct CPAP pressure to maintain an open airway, patients with obstructive sleep apnea start sleeping like people who have gone without sleep for many days. For the first week or so after starting to use the machine, patients will spend a great deal of time in deep sleep. Patients often report that there is a dramatic increase of daytime alertness and energy after just a few nights on CPAP.

Another approach to treating obstructive sleep apnea is to keep the airway open by moving the lower jaw forward. This is accomplished by a variety of dental appliances that are inserted in the mouth at night, but relatively few well-designed studies have been done to show that these appliances work well, nor has patient compliance been carefully evaluated.

Uvulopalatopharyngoplasty

In 1981, the same year that nasal CPAP was introduced, a surgical procedure called uvulopalatopharyngoplasty or UPPP was developed. The UPPP procedure was widely used until follow-up studies by sleep specialists found that it was effective in only about 10 percent of all cases.

The Stanford Surgical Approach

For more than a quarter century, the Stanford Sleep Disorders Clinic has teamed up with two outstanding ear, nose, and throat (ENT) surgeons, Drs. Nelson Powell and Robert Riley, both of whom also have degrees from dental school and have training in maxillofacial surgery. They are members of a very small group of surgeons who

qualify as sleep specialists and have worked consistently to develop new and better surgical treatments for obstructive sleep apnea. Their procedures provide a cure of obstructive sleep apnea in a majority of cases, and with rare exception, all their patients improve substantially. Their approach combines the standard UPPP with ingenious procedures to pull the large tongue muscle forward and away from the back of the throat. This is accomplished by cutting out a small rectangle of bone in the front of the jaw, to which the tongue muscle is attached. They then pull this piece of bone out, rotate it 90 degrees, so it cannot fall back, and trim and fix it permanently. This maneuver pulls the tongue forward and adds more than a centimeter to the airway diameter, without any visible external changes.

Whenever any sleep apnea patient receives a treatment, the efficacy of this treatment must always be carefully evaluated. Well over 10,000 patients have undergone this surgical procedure at Stanford, and postoperative sleep tests show that 60 to 70 percent or more are entirely cured.

New Technology

A new treatment has been developed by Nelson Powell at Stanford. The procedure is quite simple. After a local anesthetic is administered, small needles are inserted into the tissue that needs shrinking. A very precise and controlled dose of radio-frequency waves is delivered to the target tissue only at the needle tips. The area around the needle tips is coagulated and absorbed, leaving only a tiny internal scar. This treatment results in an overall reduction in tissue volume. It appears to be quite successful for reducing snoring, improving mild cases of sleep apnea, and improving seasonal rhinitis by reducing nasal turbinate tissue. Recent clinical trials show that it also works on the base of the tongue, which is the primary culprit in most cases of obstructive apnea.

This approach has numerous advantages over conventional surgery. It does not require an operating room or hospitalization. It is easily done as an outpatient procedure. The treatment itself takes only a few minutes and is bloodless and painless. Although there is some swelling immediately after the procedure, post treatment pain is much less severe than that from ordinary surgery, and what little pain there

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is can be controlled easily with over-the-counter painkillers. Because there is so little discomfort, patients are willing to come back for successive treatments. There also is no wound on the tongue or sutures that can come undone.



6

Narcolepsy and Other Sleep Disorders

Narcolepsy

Vivid hypnagogic hallucinations often occur when someone falls immediately or very rapidly into REM sleep without going through the intervening non-REM sleep stages. When REM sleep occurs so quickly, the dream story often begins exactly where wakefulness ended and is a seamless stream of consciousness from the real world to the dream world.

Such hypnagogic hallucinations are frequent, and are a true torment in patients who have a sleep disorder called narcolepsy. However, the most important and debilitating effect of this disorder is that the victims are unbearably sleepy all the time. Their struggle to stay awake is relentless and whenever they let down their guard, sleep immediately overcomes them. Even when they are on guard, they are often overtaken by sleep—in the middle of a sentence, while eating, or even during sex. Such unintended sleep “attacks” may be quite brief or may last up to 10 or 20 minutes. Often victims wake up feeling somewhat refreshed but soon afterward, they become sleepy again.

The most dramatic component of the narcolepsy syndrome is “cataplexy”—attacks of muscle weakness or near-total paralysis that occur suddenly, last for a few seconds or minutes, and vanish. People who have cataplexy might collapse into a chair or onto the floor, conscious of everything around them—able to see and hear,

but unable to move. Just as in REM sleep, the heart and breathing muscles operate normally, as do the muscles in the eyes. However, the muscles of the arms and legs remain completely limp. If the cataplectic attack persists, one can pick up the victim's arm and shake it like a rag doll's, then let it flop back to the person's side. When the episode is over, voluntary muscular control returns and is completely normal. Contributing to the strangeness of cataplexy is the fact that an attack is typically precipitated by strong emotion—anger, laughter, or just getting excited.

Despite being sleepy all day, people with narcolepsy do not sleep well at night. In fact, their sleep resembles that of people with little or no sleep debt, compared with that of normal sleepers. Narcoleptic patients typically spend much more of their night in light sleep and less time in the deepest stages of non-REM sleep. This is exactly the opposite of what is seen during the nighttime sleep that normally follows sleep deprivation.

In most cases, the first symptom of narcolepsy to appear is excessive daytime sleepiness. It may develop insidiously over several years or come on quite rapidly. The onset of cataplectic attacks may occur almost at the same time as excessive sleepiness; but the development of cataplexy is more commonly delayed two or three years. Occasionally the first manifestation of narcolepsy is hypnagogic hallucinations.

Treating Narcolepsy

At present, treatment of choice for narcolepsy is modafinil, (marketed as Provigil) which effectively blocks sleepiness and promotes alertness. Modafinil is not an amphetamine, and its action does not resemble that of conventional stimulants, which globally excite various nerve centers of the brain and cause a range of side effects from palpitations to an upset stomach. By contrast, modafinil causes few or no side effects. Tricyclic antidepressants help to reduce cataplexy. A new medication, Xyrem (sodium oxybate) helps to consolidate sleep and thus reduce daytime sleepiness and also reduces cataplectic attacks, but it is a drug that needs to be monitored closely by the patient's sleep specialist.

REM Behavior Disorder: Acting Out the Dream

Many of us may think that being told that our dreams will come true sounds idyllic, but for people with REM Behavior Disorder, that dream is a nightmare. This disorder can be regarded as the opposite of narcolepsy. In narcolepsy, the muscle paralysis of REM sleep intrudes into waking life. In REM Behavior Disorder (RBD), all the muscles that should be paralyzed during REM sleep are not. REM paralysis completely fails, and the body acts out the brain's dream. Injuries to the dreamer and the dreamer's spouse are common.

The disorder typically strikes after the age of 50, although we have seen patients as young as nine at Stanford. RBD seems to be progressive: Patients typically talk, twitch, and jerk during dreaming for years before they fully act out their REM dreams. It may also be a precursor to neurodegenerative diseases such as Parkinson's disease.

As we have learned, the dreaming brain functions very similarly to the waking brain, processing thoughts and sending out messages to move limbs. Normally the instructions to move the eyes get through, but messages to move muscles in the rest of the body are blocked before they can leave the spinal cord. In REM behavior disorder, the messages are not halted, due to the pathology in the brain stem. People may just move their arms and legs in bed or talk in their sleep, or they may actually get out of bed and run around, without ever waking up or realizing that they are dreaming.

To make matters worse, the dreams that are acted out are often violent or frightening. Such nighttime behavior is dangerous. Fortunately, a very effective treatment exists for REM behavior disorder which curtails or eliminates the disorder in about 9 out of 10 cases. It is called clonazepam, trade name Klonopin.

Sleepwalking and Night Terrors

A sleep-deprived college freshman climbs out of bed in the middle of the night, silently opens the door of his dorm room, and walks down the hallway. His roommate wakes up, sees him, and asks where he is going, but the young man just keeps walking, seemingly unable to hear anything. If his roommate stands in front of him, the sleepwalker seems to look right through him. After five minutes or so

the sleepwalker returns to bed and falls soundly asleep. In the morning he cannot remember anything about his excursion.

A four-year-old girl sits up in the middle of the night and begins screaming. Her parents rush in and find her wide-eyed in terror. The parents ask what is wrong and try to soothe her. The child does not respond to their words and does not seem to see them. She keeps staring at something, terrified. Her parents keep saying “What’s wrong, honey? What’s wrong?” Soon they are equally frightened. After five to ten seemingly interminable minutes, her crying and struggling subside, and without a word she lies down and slips back into a peaceful sleep. In the morning she cannot remember what she was frightened about or even that she was frightened at all.

These are examples of two parasomnias (Latin for “near sleep”): **sleepwalking** and **night terrors**. Like people with REM behavior disorder, people afflicted with sleepwalking and night terrors will rise out of seemingly deep sleep and act as if they are awake; they typically do not respond to other people and have no memory of the incident the next day. Unlike REM behavior disorder, however, people are not dreaming when they sleepwalk and are not having nightmares during night terrors. In fact, neither sleepwalking nor night terrors occur during REM sleep. Sleepwalking often happens when people have become very sleep deprived, and both night terrors and sleepwalking are more likely to occur in the beginning of the night when sleep debt is still high. The sleep debt will not release its grip on the brain, so the sleeper never rises out of the blunted perception and amnesia that we all experience the first few moments after waking up. In true sleepwalking, there will be some perception but not high-level cognition: Sleepwalkers may be able to recognize a door but may not be able to get the door open.

Most cases of sleepwalking and night terrors begin in early childhood, although they can continue into adulthood. Sleepwalking can begin as early as children are able to walk, but it mostly occurs between the ages of four and eight, then disappears spontaneously after adolescence.

The best therapy for sleep walking and night terrors is to focus on keeping children from harm. Speaking calmly and reassuringly to them—even though they do not respond—sometimes can slowly bring them out of their fright. Children usually calm down after 5 to 15 minutes and go back to sleep without ever really waking.

If they do wake, they are confused and unable to say what was scaring them or even remember that they were scared. They will probably forget the whole episode by morning.

Finally, a great deal of research convincingly shows that people who have any of the parasomnias—night terrors, sleepwalking, bruxism (tooth grinding), bedwetting, and the like—are no more likely to have waking psychological problems than anyone else.

Our Chronically Fatigued Syndrome

In recent years some of my sleep colleagues around the world have looked outside the laboratory for data about the effects of sleepiness and sleep deprivation on performance in real-world situations. We joined forces with a prominent jewel in the federal crown, the National Transportation Safety Board. For those who understand sleep deprivation and sleep debt, there is definitely a good and increasing awareness that a large percentage of transportation accidents are linked to sleepiness or sleep-induced lapses in awareness. A huge proportion of assembly-line accidents also are attributed to the potent combination of sleepiness and monotonous tasks. Serious efforts to gauge the full impact of fatigue due to sleep loss in critical industries such as aviation, medicine, trucking, and shipping have made it clear (at least to those with a fundamental knowledge of sleep) that the problem is worse and more pervasive than anyone has heretofore suspected.

The Anatomy of “Fatigue”

What is dangerously deceptive in the sleep deprivation arena is how awake you can feel even when you are carrying a heavy sleep load. That is because sleep debt is counteracted by arousal—both from the periodic alerting effects of the biological clock and from the alerting effects of excitement or stress. You can stave off the effects of a large sleep debt in the short term by staying engaged in stimulating activities. But the weight of sleep deprivation cannot be ignored indefinitely. Eventually it catches up with you, usually when you relax a little, or when the body's clock-dependent alerting is at

its lowest points during the early morning and the early afternoon. When arousal temporarily subsides, your underlying sleep drive is unleashed like a dammed-up river, and you are in grave danger of being rapidly overcome by sleep, no matter where you are or what you are doing.

Sleep deprivation is the most common brain impairment. Time after time, records of various transportation disasters show that people who are sleep deprived react to dangerous situations with indifference. Before a plane crashed on approach to the Guantanamo Naval Base in Cuba—the first major airplane crash to be officially attributed by the National Transportation Safety Board to crew fatigue—the sleep-deprived crew inexplicably pursued a difficult approach instead of an easier one. Before the Chernobyl nuclear reactor melted down—in the wee hours of the morning, when clock-dependent alerting is at its lowest point—the engineers clearly noticed but bizarrely did not respond to critical warnings that should have caused panic.

When the brain has been slipping back and forth between sleep and wakefulness, it can go on autopilot, producing what is called **automatic behavior**. Most people have experienced this at some time. You are driving or walking down the road, and suddenly cannot remember what has happened or what you have seen over the last 10 or 15 minutes, sometimes much longer. You were functioning reasonably well—you were able to avoid bumping into anything—but you were not laying down the usual memory traces. It is almost like sleepwalking, except that it arises out of wakefulness rather than sleep. As sleep debt increases, automatic behavior becomes more common.



Face Up to Your Sleep Problems

Deal with “Emergencies” First

By “emergency,” I mean there should be no delay in addressing the problem, because a catastrophe can happen at anytime. The number one danger from all sleep disorders is an accident due to fatigue. For sleep apnea, there is also the danger of a fatal arrhythmia, heart attack, or stroke.

Making a Self-Diagnosis

I believe it is safe to say that the single symptom most frequently found in all severe sleep disorders is daytime fatigue. I should reemphasize that people who feel fatigued complain of lack of motivation, apathy, and irritability, but rarely complain of excessive sleepiness mainly because being in an actual state of sleepiness usually requires the absence of stimulation. They usually say they are worn out, exhausted, or depressed. Such people do not know that a sleep disorder is a possible cause of the fatigue, and usually think they must have some other medical problem instead. Only unambiguous, recurring drowsiness—requiring a real effort to stay awake throughout the day—finally causes people to admit they are excessively sleep deprived.

Doctors tend to make the same mistake. Although sleep specialists have known for years that fatigue is very often associated with sleep deprivation and/or sleep disorders, primary physi-

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cians continue to look elsewhere for explanations. When they cannot unambiguously identify the source of the fatigue, the problem often gets labeled chronic fatigue syndrome or depression. In marked contrast, the results of our primary care project strongly indicate that when fatigue is the patient's major complaint, a sleep disorder is the culprit in more than half the cases. *For my part, I always assume that fatigue is obstructive sleep apnea until proven otherwise.*

I usually assess patients' or anyone's level of sleepiness by first asking "Are you generally wide awake, energetic, and highly motivated all day long?" If their reply is an unambiguous yes, it is very unlikely that they have a serious or persistent sleep problem. If such individuals are also cheerful, optimistic, or happy, a sleep problem is even less likely. Those who say they are not at this optimal level of alertness and energy are candidates for a sleep disorder and should be questioned further. Keep in mind that denying daytime sleepiness is not the same as claiming to be wide awake and energetic all day long.

If you snore, in addition to being very tired during the daytime, then you could have either obstructive sleep apnea or upper airway resistance syndrome. Either problem can be effectively treated. If you snore, consider apnea a likely explanation if you are fatigued, substantially overweight, and accustomed to waking up with a sore throat and/or headache. You should definitely investigate further if you have any possibility of apnea and have high blood pressure or any cardiovascular problem—doing so could save your life.

One simple way to tell if you snore or stop breathing at night is to place a tape recorder near your pillow and set it to record while you sleep. If you have the equipment, videotaping is even better. If you become convinced you may have sleep apnea, do something! If you are among the 70 percent of the population who sleep with someone, ask your bed partner to observe your breathing when you are asleep.

Periodic limb movement disorder, mentioned in chapter 4, in its extreme form should be infuriatingly obvious to anyone sharing your bed. Restless legs syndrome is absolutely obvious to anyone once they know that the disorder is characterized by uncomfortable, tingling, aching, or creepy, crawly feelings in legs when they lie down.

Nonetheless, nearly all victims remain undiagnosed because neither they nor their physicians are aware their disorder exists or is so very common.

The Patients Who Never Were

Even when people are told or suspect they may have a sleep disorder, they themselves can be the major barrier to successful treatment. I got a more detailed glimpse of how much people can resist treatment in the case of a Stanford student, Sarah C., who worked several summers in the Stanford Sleep Disorders Clinic and learned all about obstructive sleep apnea. When Sarah went home to rural New Mexico for the holidays, she listened to her father while he slept and heard him snore and stop breathing many times. She told him what was wrong and tried to convince him to do something. Because of the fear that someone with severe obstructive sleep apnea will suddenly die, or have a heart attack or a stroke, or an auto accident, the motivation to push a loved one into seeking help is very intense. Sarah pressed her father very hard, but he would not listen and finally said she could come home only if she never mentioned the topic again.

Meanwhile her father had to stop driving his car because of his increasing fatigue and sleepiness. This greatly increased his isolation and further diminished the quality of his life. Even with this loss, he resisted treatment. Fortunately, his insensitivity to his daughter motivated his son to get involved. The son traveled to New Mexico and spent a night with his father. He carefully counted and timed all the apneic episodes, and videotaped his father asleep for about an hour. He was able to say to his father the next morning, "Dad, you stopped breathing 400 times, and each episode lasted for over a minute. You turned purple and I can prove it. You've got to get to a sleep specialist." Playing the videotape and watching himself strangle finally did it. The father obtained expert help in a sleep center. The diagnosis was confirmed and treatment was initiated. The change was miraculous. He woke up, his daytime alertness returned, and he is driving again.

FACE UP TO YOUR SLEEP PROBLEMS

I am convinced that many people think it is normal to be tired all the time. In one of our primary care sites, three-quarters of all patients interviewed admitted to varying degrees of trouble sleeping, but none had mentioned the difficulty to a doctor. Included among the silent sufferers were 30 percent of all patients in this site whose trouble sleeping was severe enough to have daytime consequences, interfering with work and other activities.

If the only result of a sleep disorder is fatigue, many people simply do not recognize their fatigue or acknowledge that it is a symptom of something larger—rather, they simply accept it as normal. And even when they admit to fatigue, they may come up with any number of justifications, such as “It’s just a part of growing older.”

Getting Help from Doctors

The primary care physician at the front line of the medical care is the first to identify a health problem, evaluate its seriousness, treat the patient, or refer the patient to a specialist. However, their lack of knowledge about sleep disorders means that victims of severe restless legs syndrome are misdiagnosed with various psychiatric disorders and treated with strong tranquilizers. Obstructive sleep apnea patients are often treated for “misdiagnosed” depression. Children with sleep disorders are commonly diagnosed as having attention deficit disorder.

Here are the points to keep in mind when talking to your doctor about sleep:

- **Point 1:** *Make your appointment specifically to talk about your sleep problem.* I cannot overemphasize how important this is. Do not go see the doctor about itchy skin and then bring up your sleep problem at the end of the visit. By setting an appointment specifically for the sleep problem, you are letting the physician know you take it seriously and expect him or her to take it seriously, also.
- **Point 2:** Do not be afraid to bring in material you have read to support your complaint. You already have learned a great deal about sleep by reading this book. Do not be shy about using this informa-

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tion. Show this book to your doctor as well as anything else you can gather from other sources. If you think you have apnea, insomnia, restless legs, or some other disorder, pickup information from the appropriate sleep disorders associations or patient support groups and bring it to your appointment.

- **Point 3:** Remember that doctors are people. They care a great deal about their patients and are justifiably proud of the years of medical training that they have gone through. So when talking about sleep problems to a doctor, you need to walk a fine line between assertiveness and collaboration. You should not go in immediately demanding sleeping pills or a continuous positive airway pressure (CPAP) machine for your apnea.

- **Point 4:** Be persistent. If you do not feel a doctor has answered your concerns, ask again. If you leave the doctor's office with issues still unresolved, make another appointment and bring them up again. A recent study of elderly patient care published in the British medical journal *Lancet* showed, not surprisingly, that doctors disliked treating patients who were demanding, preferring the more compliant types. Yet those doctors also tended to make more mistakes treating compliant patients or did not treat them as aggressively. The demanding patients ended up getting better care and living longer.

- **Point 5:** Lay the groundwork now for future problem-solving. Even if your problem seems as mild as insomnia a few times a year, mention that you are reading a book on sleep disorders and ask your doctor if he or she sees many patients with sleep disorders. Doctors should be detecting at least a few cases of sleep apnea and insomnia every year. If they really are on top of the field, they should spot apnea in about 10 percent of their patients.

If you have occasional bouts of insomnia, mention that when an episode occurs, you would like to be able to get one or two nights' worth of sleeping pills on short notice. One good arrangement is to call your doctor when you have a particularly stressful day coming up and are worried about sleeping the night before, so the doctor can call in a prescription to the pharmacy.

• **Point 6:** Know when and how to find a sleep specialist. My fervent hope is that someday people will need to see a sleep specialist mainly for rare, complex, or treatment-resistant sleep disorders because primary care physicians will be qualified to treat most cases of insomnia, restless legs syndrome, straightforward sleep apnea, and other common sleep disorders. Every medical group and clinic should have a knowledgeable nurse or nurse practitioner on staff who will be able to spend a fair amount of time working with patients on various insomnia-fighting techniques or getting the right fit and pressure on a CPAP mask. Until that day arrives, the reality is that in most instances you may need to see a specialist for the many kinds of sleep disorders that primary care physicians are unable to treat. If you have a good relationship with your primary care doctor, discuss your case with him or her first. But if you are not getting results, do not get into a battle over treatment with your doctor. Suggest that he or she refer you to a sleep specialist. Every accredited sleep disorders center in the country is listed on the American Academy of Sleep Medicine website at www.aasmnet.org. Take a printout of the list to your appointment.

Managing “Sleep Crises”

I cannot emphasize often enough that if you are driving or doing some other potentially dangerous activity, and you feel sleep tugging your eyelids down, you absolutely must stop. This is one life-and-death sleep crisis. You are seconds from tragedy and should hear a warning alarm blaring in your head. You should feel and act as you would if you heard a police siren and saw flashing red lights right behind you: You pull over immediately. No job, no vacation, no goal, is worth endangering your life—or the lives of others.

Understanding

The paramount piece of knowledge that everyone must master is that drowsiness can become sleep in an instant. Without warning. Once your eyelids start feeling heavy, you are only a few seconds from sleep. An analogy that comes to mind has to do with

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the cliffs overlooking the Pacific Ocean located 30 miles west of Stanford, California. Every once in a while people ignore the warning signs and walk along the cliff edge. They think they can keep from going over by staying a step or two back from the edge and carefully watching their footing. But then, without warning, the soil gives out from under their feet and they plunge to the rocks below. Likewise, too many people are tempted to think they know exactly when they are in danger of falling asleep and that they can safely skirt the abyss. But when wakefulness suddenly slides out from underneath them, they are powerless to save themselves.

No one wants to die or be horribly injured or brain damaged because of drowsy driving. The feeling of drowsiness is the warning sign at the edge of the cliff. *Drowsiness is red alert!*

Napping

Napping is by far the most important and effective tool for coping with sleep crises. Naps can make you smarter, faster, and safer than you would be without them. They should be widely recognized as a powerful tool in battling fatigue, and the person who chooses to nap when others “press on” should be regarded as the true hero.

From the point of view of managing the sleep and alertness in your life, naps can be roughly categorized as follows: the emergency nap that is used to cope with drowsiness in hazardous situations; the preventive nap, taken, for example, when an individual has to stay up all night, or a nap in the afternoon to be more alert at a dinner party or the opera; and finally, the habitual nap. Some habitual nappers take a nap every day at more or less the same time, usually after lunch.

Regular napping is a completely natural answer to a biological call. The opponent process model allows us to understand the midday dip in alertness as a slight lull between the morning period of clock-dependent alerting and the evening period. Accordingly, our minds and bodies are more inclined to sleep after lunch and during midafternoon than during any other daytime period. Napping in the evening is generally a bad idea, because once your midday dip in alertness is past, the nap will not be as efficient and you may not be able to nap at all.

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Coffee and tea are by far the most widely used tools for combatting fatigue currently, and I have no reservations about using them to get a boost. What most people do not realize, however, is that naps and caffeine can be additive. For the occasional all-nighter, a 4-hour nap, from 4:00 p.m. to 8:00 p.m., combined with 200 milligrams of caffeine (two strong cups of coffee) at 1:30 a.m. and another two cups at 6:30 a.m. kept performance and alertness at daytime levels.

I often feel that if I am tired and sleepy but not actually struggling to stay awake, there is a good chance that I will not fall asleep if I try to nap. However, I have learned that if I am patient, I usually can. But picking a good time for a nap is important. If sleep debt is low, I will not be able to take a daytime nap outside of the mid-afternoon dip. Some people have trouble napping in the late afternoon because they feel sleepy during the afternoon, but put off their nap until later, when clock-dependent alerting is typically on the rise. As far as possible, an intended nap should be scheduled at the right time and in the right environment.

Surviving Driving

For people who drive long distances on the job, live far from relatives, or take car vacations to distant resorts, road trips are a fact of life. But increasingly, the typical commuter also contends with a long, tiring drive twice daily—average one-way commute times in major metropolitan areas are approaching 60 minutes. Driving is monotonous, it is not very challenging mentally, and it does not involve much physical effort. All of these factors relax drivers, diminish psychological alerting, and unmask the sleep debt lurking in the brain. Driving provides a terrible combination of increased risk of falling asleep and thus increased risk of injury or death.

To reiterate the life-saving message I feel you must take away from this book: The subjective feeling of sleepiness is due to a combination of underlying sleep debt, the degree of alerting provided by the biological clock, and the amount of stimulation provided by the world around us. A high sleep debt and low clock-dependent alerting become extremely dangerous in monotonous situations. Depending on the phase of your clock-dependent alerting, a very large sleep debt can make you dangerously drowsy even during a peak in alert-

ing. The only way to be sure that you will remain alert during a long drive is to have a low sleep debt and to drive during periods of peak alerting.

If, despite all your planning, you find yourself feeling drowsy on the road and have no one else to take over the driving, you must immediately find a safe place to take a nap. Coffee can help you stay alert if your sleep debt is low, but at high sleep debt levels there is no substitute for sleep. As I have said before, a nap does not have to be long to have a big impact on your alertness. A 15 to 30 minute nap can move you back from the edge of the abyss. If you can nap until you awaken naturally, that is even better.

Jetting to Hell

In recent decades, we have been able to travel faster than our biological clocks can be reset. As a result, our circadian rhythm is often out of synchrony with the local rising and falling of the sun. Plane and jet travel gave birth to a peculiar twentieth-century malady commonly known as **jet lag**. In a nutshell, jet lag is feeling sleepy when everyone else is wide awake and having insomnia when everyone else is sleeping. About half of people experiencing jet lag also feel nauseated, and nearly all feel hungry at odd hours or not hungry at mealtimes. People with jet lag are distracted and fuzzy-headed, so out of sync with their normal body rhythms that they can feel as if they were sick with a flu virus.

On average, the body needs about one day for every time zone crossed in order to adjust to jet lag. So for a trip from New York to London, which is five time zones away, it usually takes at least five days for the body's temperature and hormonal rhythms to adjust to the new time. Yet everyone does not feel the symptoms of jet lag for five days. Some people actually feel better in a day or two, while others feel lousy for a week. Susceptibility to the symptoms of jet lag is determined partly by the peculiarities of an individual's circadian cycle and partly by the amount of his or her sleep debt at the time of travel.

There is no question that it is usually easier to adjust when flying west than when flying east. People used to say this was because our "natural" circadian rhythm is closer to 25 hours than to

24. Consequently, getting to bed later (flying west) works with our natural rhythm and getting to bed earlier (flying east) works against it. More recently, we have learned that our natural circadian rhythm is only a little more than 24 hours. Even so, it is easier to fly westward at least partly because it is easier to stay awake when clock-dependent alerting is in decline than to go to sleep when the clock-dependent alerting is strong.

Strategies for Dealing with Jet Lag

Remember that the mismatch between our internal clock and the external (local) clock is the cause of jet lag. Accordingly, the first step is to calculate when your strong clock-dependent alerting will be occurring in the new time zone. For instance, the time difference between New York and Paris is six hours. If New Yorkers fly to Paris and arrive in the early evening, their biological clock will tell them that it is early afternoon. Our New York travelers may even feel a little bit tired, because their midafternoon dip in alerting is just happening. They have dinner and go to bed at 10:00 p.m. but cannot stay asleep. Why? They are trying to sleep just as their biological clocks are swinging into the strong evening alerting period. Let us assume our travelers have biological alerting that is very strong from 6:00 p.m. to midnight at home. This “forbidden zone,” when sleep is almost impossible now extends from midnight to 6:00 a.m. in Paris. This is why our travelers may fall asleep briefly in the hotel room but wake shortly afterward and are unable to go to sleep for hours.

I would strongly recommend that these travelers plan to stay up, tour Paris, and see the sights at night. Paris at night may be even more beautiful than Paris in the daytime. They should go to bed in the early morning and continuously sleep until early afternoon. Getting out immediately into the bright light of early afternoon could help advance the circadian clock, which is good to do if travelers plan to spend more than a day or two in the new time zone.

Business travelers making the U.S. to Europe trip should try to schedule afternoon and evening meetings so that they are alert. If this is not possible, and travelers want to be at peak alertness in the morning, they should take a sleeping pill or attempt to advance their biological clock a few hours in the days before the trip. Probably the

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number-one fact in dealing with jet lag is the duration of the stay in the new time zone. If the visit is only one or two days, it makes no sense to reset your clock, since you will only have to reset it again when you go home.

Let us say, on the other hand, that our New York travelers arrive in Paris at 8:00 a.m. Now their biological alerting is falling rapidly, since it is 2:00 a.m. in New York. If they have a lot of sleep debt, they will feel terrible throughout the whole morning. In the afternoon they may feel a little better, because their morning alerting may start to kick in around noon in Paris (6:00 a.m. New York time). But morning alerting is fairly weak and by this time they have accumulated an even larger sleep debt. Accordingly they will still feel terrible. The ultimate irony is that by the time evening rolls around and they allow themselves to sleep, they cannot stay asleep for long because the strong evening alerting is just coming into play.

There are three ways to reset the biological clock: exposure to bright light, ingestion of melatonin, and physical activity. To work effectively, these interventions must be scheduled at the proper time. There are, however, individual differences in how people react to each of these methods. Readers who intend to follow some of the recommendations for travelers and shift workers should understand their own sensitivity and what to expect. In general, if you are trying to shift your clock forward (flying east), spend some time in direct sunlight as soon as the sun comes up. To shift your clock back (flying west), sleep late in the morning and get out in the sun in the late afternoon.

Whether you decide to nap or stay awake during the flight depends on whether you want to be awake or falling asleep when you arrive. For example, someone flying from San Francisco to New York with an evening arrival should avoid naps during the flight in order to be good and tired from traveling and ready for an earlier-than-usual bedtime. On the trip home, the person should take a nap on the plane so he or she can stay up later and adjust to Pacific Standard Time again.

Shift Work

A common shift work schedule is three shifts of 8 hours apiece. These shifts are still called the day shift (8:00 a.m. to 4:00

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p.m.), the evening or “swing” shift (4:00 p.m. to 12:00 a.m.), and the night or “graveyard” shift (12:00 a.m. to 8:00 a.m.). Workers are rotated in order to spread the undesirable shifts evenly.

Theoretically, it should be possible for people to adapt to working at night and sleeping during the day just as we can adapt to a new time zone after a few days. But workers do not ever completely adapt; night workers revert to a daytime schedule on weekends and vacations when, let us face it, people want to see their kids, spend time with their spouses, pursue outdoor activities, have a life. The only way they can do this is to break their nocturnal schedule, usually just when they are getting used to it. Studies show that shift workers commonly get two hours less sleep when their sleep time is during the day as opposed to during the night.

This brings up the second major problem with shift work. Due to shift rotation, workers never become reasonably adjusted to any single schedule. The brain is often fighting to go to sleep when work demands are being made and resisting sleep when bedtime arrives. The most common rotation schedule in the United States is one week per shift, followed by a “counterclockwise” change to the previous period (night shift to evening shift, evening to day, and day to nightshift). This is the worst possible combination; a week is just long enough to become somewhat acclimated to a schedule, and it is more difficult to make a counterclockwise change than a clockwise one. I must also point out that a counterclockwise rotation is analogous to flying in an eastward direction. Just as workers are beginning to acclimate to a shift after one week, another eight-hour phase shift is imposed on their biological clock. And that phase shift is in the more difficult direction, demanding alertness just when clock-dependent alerting is lowest. For instance, going from the dayshift to the evening shift is not a problem—starting at 4:00 p.m. and working until midnight only means staying up a little later than you normally would. But moving from the day shift back to the graveyard shift demands that workers start work just as clock-dependent alerting is descending to its weakest point in the day.

Sleep experts have long consulted on shift work for various businesses as well as for police and fire departments. For one company in Utah, we recommended a change from a one-week counterclockwise shift rotation to a three-week clockwise rotation (day to

evening, evening to night, and night to day). The three-week periods gave workers a week to make the adjustment to the new schedule and two weeks to maintain it. When it came time to rotate, it was to the later shift, which is easier to adapt to. More than 70 percent of the workers preferred the new schedule, and there were fewer complaints of sleep and various other health problems. The company reported a 20 to 30 percent increase in productivity and lower absentee rates.

Take Age into Account

The Later Years

No one should passively accept a higher level of daytime fatigue and sleepiness as a normal part of growing older, even if sleep disorders have been ruled out as the cause. Researchers in geriatrics have demonstrated that for elderly people, exercise improves bone density, heart function, and the general feeling of well-being. A number of studies also have shown that exercise during the day improves sleep: People who exercise have fewer awakenings, fall asleep faster, and spend more time in deep sleep. The rewards of exercise for physical health and mood are just as high in old age; we simply need to be smarter and more cautious than in our youth about the kinds of activities we try.

The underlying message is that as you get older, your sleep health, like other aspects of your health, requires more attention and work. You cannot just assume any longer that you will fall asleep at the end of the day and sleep well. As you get older, you have to watch what you eat and get the right kind of exercise. You also have to manage your sleep. This means planning how you accumulate and pay off sleep debt—sleeping enough to enjoy a vital day.

Medicating the Sleep Cycles of Aging

If long-term use of sleeping pills by elderly patients is to be considered seriously, there are now several safe and effective medications. These are Ambien, Sonata, Lunesta, and Rozerem each of which have passed adequate double-blind, controlled clinical trials to verify safety and efficacy in elderly patients. These drugs do not induce tolerance or cause rebound insomnia when used in the proper

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doses (which should be lower than the young adult dose), so their long-term use is no more problematic than prolonged use of heart medication, or daily insulin by diabetics.

Ultimately, improved melatonin pills and other similar drugs of the future may better synchronize elderly biological clocks with the cycles of night and day. We know that melatonin production in the body wanes as we age, so melatonin replacement therapy may one day be as common as estrogen replacement therapy. I also think that we should be looking at restoring the alerting processes of the biological clock. Stimulants may provide a safe means of replacing clock-dependent alerting if the brain is not doing the job anymore.



Final Admonition: Adopt a Sleep-Smart Lifestyle

Keys to Smart Sleep

When I talk to an audience I often ask, “How many of you sleep well and feel wide awake and energetic all day long?” Usually only a few hands are raised. If you are one of the majority whose daytime alertness is less than optimal because your sleep is less than optimal, here are just a few questions to determine how sleep smart your lifestyle is (Remember, repetition is good):

1. Do you carefully avoid caffeinated drinks in the evening?
2. Do you typically schedule your evening meal at least three hours before you go to bed?
3. Do you have a regular bedtime, which you follow with rare exceptions?
4. Do you have a bedtime ritual, such as a hot bath and perhaps reading a few pages, relaxing, while drowsiness sneaks up on you?
5. Is your bedroom generally a quiet place all night long?
6. Is the temperature of your bedroom just right?
7. Do you think of your bed, particularly the mattress and pillows, as the most comfortable place in the world?
8. Are the bedclothes (blankets, quilts, comforters) exactly right for you?

ADOPT A SLEEP-SMART LIFESTYLE

If you answered “no” to any of these questions, you might look at that particular area of your life as a possible hiding place for sleep problems. Maybe caffeine in the evening does not affect you. Perhaps the temperature in your bedroom does not matter in the slightest. But if you have not considered all the factors that might negatively affect your sleep, you are not acting in an informed manner.

One of the above tips is to get to bed the same time everyday, but to make this idea work in your own life, you have to understand why regularity tends to make both sleep and wakefulness more robust. One of the results of such regularity is that you start falling asleep faster and waking up more easily. Psychologically and physiologically, you become conditioned for sleep. With a set pre-sleep routine, an understanding of your natural periods of clock-dependent alerting, and a predictable bedtime, you will be relaxed and getting drowsy as you approach sleep. This psychological and physiological rhythm in turn makes it easier to fall asleep and stay asleep.

People who need an alarm clock to wake up on time are often being jolted from a deep sleep because the brain is not ready to wake up. Whoever invented the snooze button understood that it takes a barrage of wake-up calls to rouse the severely sleep deprived. On the other hand, if you are getting enough sleep the brain should usually wake up naturally at its normal time without an alarm clock. This happens because the clock-dependent alerting process increases naturally in the morning. With very low sleep debt to oppose this alerting, waking up should not be difficult and you will usually awaken spontaneously at about the same time, and if it is at an hour that allows adequate time to get to work or to be somewhere, there is no problem.

The Sleep Environment

The fundamental principle with regards to your sleep environment is that the bedroom should be a comfortable, secure, quiet, and dark place that promotes sleep above all else, taking into consideration what works best for you individually. This means if you feel most comfortable with a bedroom that is completely uncontaminated by work, ban the computer.

ADOPT A SLEEP-SMART LIFESTYLE

Perhaps the most important environmental factor is noise. Most sleep tips will tell you to make sure the bedroom is quiet.

The bedroom should generally be dark during sleep. Although people may feel more comfortable falling asleep with a little light on, too much light at night can have the effect of shifting the biological clock.

I may be wrong, but I do not believe a single how-to book about improving sleep recognizes or takes into account that the vast majority of adults sleep with someone: over 70 percent of Americans do not sleep alone. The preferences and tendencies of a bedmate or roommate have a huge effect on anyone's sleep. This means that all the advice about the sleep environment and finding what really suits you must also suit your bed partner, or at least there must be a compromise.

Daily Sleep Need

The most basic and important bit of sleep self-knowledge is how much total sleep you need on the average in each 24-hour period to keep sleep load and alertness in optimal balance. Remember that just as a thermostat keeps a room at a constant temperature, your own sleep homeostat works to make you fulfill your daily sleep quota. You accumulate sleep debt at a certain rate and have to pay it off by sleeping a certain amount each day. You may be a naturally short sleeper, needing fewer than eight hours a night to achieve this equilibrium, or a long sleeper, needing more.

My favorite method of determining whether I am maintaining a reasonable sleep “diet” is to keep track of my episodes of heavy eyelids and struggling to stay awake, and the circumstances in which they take place. I am now so sensitive to these events that I know exactly how often they tend to happen. I am convinced that most people do not know this about themselves, but I am also convinced that everyone can learn. The enclosed sleep diary may be helpful.



Adopt a Sleep-Smart Lifestyle

SLEEP DIARY

Date _____

Complete after awakening

Time you went to bed _____

Time you fell asleep _____

Time you woke up _____

Number of times awakened during the night _____

Amount of time awake during the night _____

Total Nighttime Sleep _____

Comments on quality of night's sleep

Did you feel groggy after getting up in the morning? Yes ___ No ___

If yes, for how long? _____

Complete during and at the end of the day:

Naps:

Time fell asleep _____

Time awoke _____

Total Nap Time _____

Comments on quality of naps:

Using the Stanford Sleepiness Scale below, note your alertness during the day:

- 1) Feeling active, vital, alert, wide awake
- 2) Functioning at a high level, not at peak
- 3) Relaxed, not full alertness, responsive
- 4) A little foggy, not at peak, let down
- 5) Fogginess, losing interest, slowed down
- 6) Sleepiness, prefer to be lying down
- 7) Almost in a reverie, hard to stay awake

6AM		4PM	
8AM		6PM	
10AM		8PM	
Noon		10PM	
2PM		MDNT	

How was your overall sleepiness/alertness today? (1-7) _____

Other comments on mental and physical feelings in the day:

For more information about sleep, empowering knowledge to aid you in living life at peak alertness, and to stay up to date with Stanford Sleep and Dreams, visit

www.End-Your-Sleep-Deprivation.com