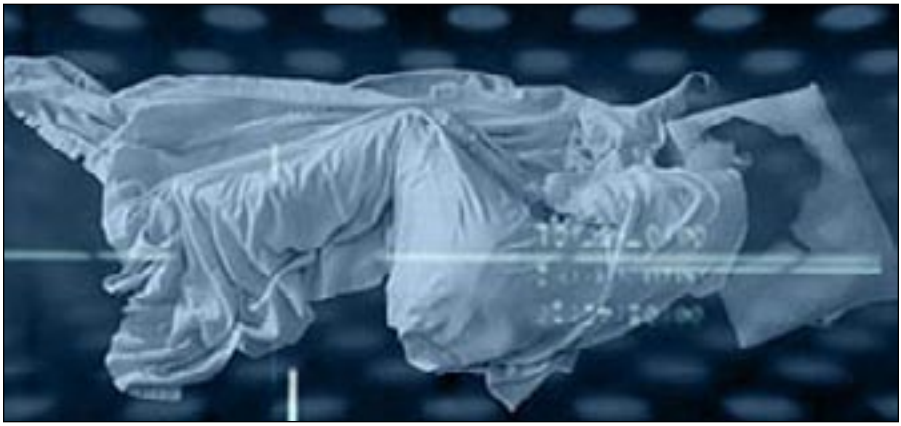
Health

The New York Times

Sleep



NIGHT LIFE Why do we sleep, anyway? How much sleep do we need? Do we sleep differently as we get older? Do sleeping pills really help? What are dreams made of, and why do we have nightmares? This Times special report looks at a cascade of new research that is trying to answer those questions — and, in the process, is raising new ones.

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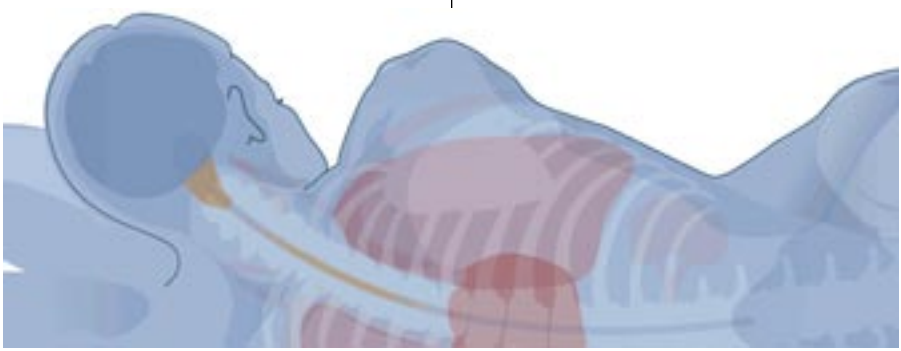

MIKA GRÖNDAHL/THE NEW YORK TIMES

Health: Sleep

The New York Times

The Elderly Always Sleep Worse, And Other Myths of Aging

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Poor sleep among the elderly, it turns out, is not because of aging itself, but mostly because of illnesses or the medications used to treat them.

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Some neuroscientists say that at least one vital function of sleep is tied to learning and memory, and new findings suggest that sleep plays a crucial role in flagging and storing important memories.

An Active, Purposeful Machine That Comes Out at Night to Play

By BENEDICT CAREY

The task looks as simple as a "Sesame Street" exercise. Study pairs of Easter eggs on a computer screen and memorize how the computer has arranged them: the aqua egg over the rainbow one, the paisley over the coral one — and there are just six eggs in all.

Most people can study these pairs for about 20 minutes and ace a test on them, even a day later. But they're much less accurate in choosing between two eggs that have not been directly compared: Aqua trumped rainbow but does that mean it trumps paisley? It's hazy.

It's hazy, that is, until you sleep on it.

In a study published in May, researchers at Harvard and McGill Universities reported that participants who slept after playing this game scored significantly higher on a retest than those who did not sleep. While asleep they apparently figured out what they didn't

while awake: the structure of the simple hierarchy that linked the pairs, paisley over aqua over rainbow, and so on.

"We think what's happening during sleep is that you open the aperture of memory and are able to see this bigger picture," said the study's senior author, Matthew Walker, a neuroscientist who is now at the University of California, Berkeley. He added that many such insights occurred "only when you enter this wonder-world of sleep."

Scientists have been trying to determine why people need sleep for more than 100 years. They have not learned much more than what every new parent quickly finds out: sleep loss makes you more reckless, more emotionally fragile, less able to concentrate and almost certainly more vulnerable to infection. They know, too, that some people get by on as few as three hours a night, even less, and that there are hearty souls who have stayed up for more than week without significant health problems.

My experience was that one can survive on two to three hours of sleep per night — with occasional naps — for two or three weeks. After that, all pretenses of rationality were blown. I've since asked sleep scientists what happens to your brain in a three-minute nap that restores your ability to drive, teach, think and yell at grad students. They've never answered.

LEON M. LEDERMAN, WINNER OF THE NOBEL PRIZE IN PHYSICS

Now, a small group of neuroscientists is arguing that at least one vital function of sleep is bound up with learning and memory. A cascade of new findings, in animals and humans, suggest that sleep plays a critical role in flagging and storing important memories, both intellectual and physical, and perhaps in seeing subtle connections that were invisible during waking — a new way to solve a math or Easter egg problem, even an unseen pattern causing stress in a marriage.

The theory is controversial, and some scientists insist that it's still far from clear whether the sleeping brain can do anything with memories that the waking brain doesn't also do, in moments of quiet contemplation.

Yet the new research underscores a vast transformation in the way scientists have come to understand the sleeping brain. Once seen as a blank screen, a metaphor for death, it has emerged as an active, purposeful machine, a secretive intelligence that comes out at night to play — and to work — during periods of dreaming and during the netherworld chasms known as deep sleep.

"To do science you have to have an idea, and for years no one had one; they saw sleep as nothing but an annihilation of consciousness," said Dr. J. Allan Hobson, a psychiatry professor at Harvard. "Now we know different, and we've got some very good ideas about what's going on."

The evidence was there all along. Infants make sucking motions when asleep, and their closed eyelids quiver, as if the eyeballs beneath had a life of their own. But it wasn't until the early 1950s, in a lab at the University of Chicago, that scientists recorded and identified what was happening.

Eugene Aserinsky, then a graduate student in physiology, reportedly was monitoring sleep and waking in his 8-year-old son, using electronic leads stuck to

the boy's head, connected to a brain-wave detecting machine. He had attached two leads to the boy's eyelids as well, so he could tell whether his son woke up. One night he noticed percolating wave patterns that showed the boy had awoken. But he hadn't.

Dr. Aserinsky confirmed the activity in others, and in 1953 he and his adviser, Nathaniel Kleitman, published the finding in a now-famous paper in Science. They later called the odd, unconscious state rapid eye movement, or REM, sleep.

"This was really the beginning of modern sleep research, though you wouldn't have known it at the time," said Dr. William Dement, then a medical student in Dr. Kleitman's lab and now a professor of psychiatry and sleep medicine at Stanford University. "It took years for people to realize what we had."

Dr. Dement, infatuated with Freud's theories about dreams, quickly threw himself into the study of REM. He found that it was universal and occurred pe-

If sleep doesn't serve an absolutely vital function, it is the biggest mistake evolution ever made.

ALLAN RECHTSCHAFFEN, UNIVERSITY OF CHICAGO SLEEP RESEARCHER

• • • • • • • • •

Now blessings on him that first invented this same sleep! It covers a man all over, thoughts and all, like a cloak; 'tis meat for the hungry, drink for the thirsty, heat for the cold, and cold for the hot. 'Tis the current coin that purchases all the pleasures of the world cheap; and the balance that sets the king and the shepherd, the fool and the wise man even.

CERVANTES, "DON QUIXOTE"

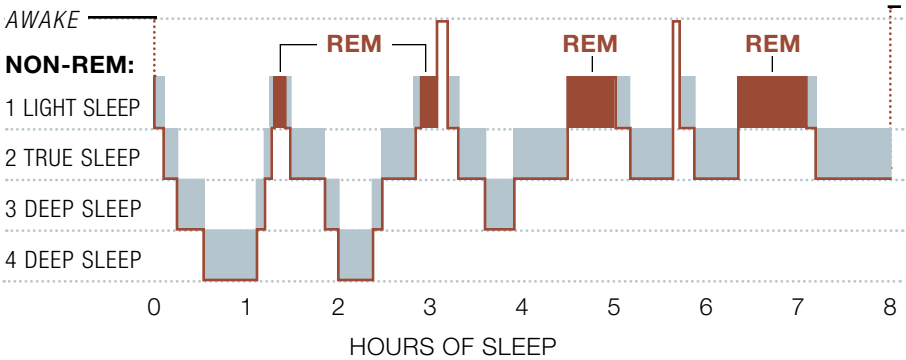
riodically through the night, alternating with other states. He gave them names: Stages 3 and 4, or deep sleep, when electrical waves roll as slow as mid-ocean swells; Stage 2, an intermediate stage between REM and deep sleep; and Stage 1, light sleep.

He also confirmed the link between REM and dreaming, and for a time hopes for sleep research — and money for it — soared.

Yet Drs. Dement, Hobson and others found in their studies scant evidence to confirm that dreams were the disguised, forbidden wishes described by Freud. They found instead a tangle of apparent anxieties, fantasy and vivid, often nonsensical replays of events that showed

Asleep but Active

Normal sleep consists of REM (rapid eye movement) and non-REM sleep, which has phases of various depth. A typical night begins with non-REM sleep in a sequence from light to deep and back to light, followed by REM sleep. In adults, one night's sleep can consist of five to six such cycles, each lasting 90 to 120 minutes. Younger children have more and shorter cycles.



Sources: Dr. Chun Bai, SUNY Downstate Medical Center; Dr. Subimal Datta, Boston University

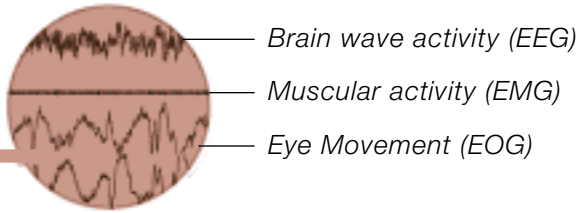
few verifiable patterns or measurable function.

They had hit a wall, and sleep research, like its nocturnal subjects, dropped from REM excitement back into a void. “You had this great excitement, basically followed by 40 years of nothing; it was just horrible,” said Robert Stickgold, a cognitive neuroscientist at Harvard. “Just a period of darkness.”

The sun came up in 1994, in Rehovot, Israel. There, a research team led by Avi Karni found that depriving people of REM sleep undermined memory of patterns they had learned the day before, while depriving them of deep sleep did not.

This result raised more questions than it answered — Were

REM Sleep



The brain is very active. This is the period when most dreams occur. Eyes dart around; breathing rate and blood pressure vary widely. Limbs are effectively paralyzed, because a control region in the brain stem sends signals to shut off neurons in the spinal cord, preventing us from acting on our dreams.

Body temperature control changes. No sweating or shivering occurs in response to changes in room temperature.

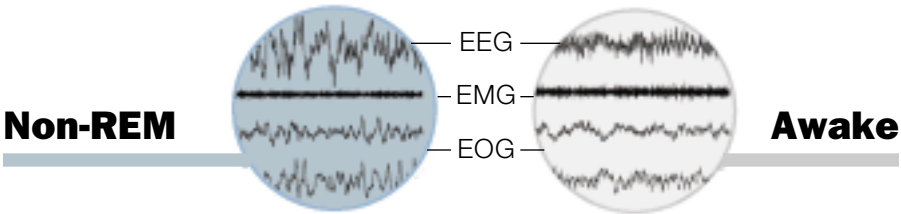
Sources: Dr. Chun Bai, SUNY Downstate Medical Center; Dr. Subimal Datta, Boston University

the participants simply sleepy, or stressed? Why just REM? What was the purpose of the other sleep states? — but it was an invitation to researchers interested in sleep.

"I called Karni immediately, and he sent me all his protocols, everything," Dr. Stickgold said.

Others called, too. The field was waking up, and now turning its focus to a long-neglected area: learning and memory.

Since then the study findings have come almost too fast to digest, and they suggest that the sleeping brain works on learned information the way a change sorter does on coins. It seems first to distill the day's memories before separating them — vocabulary, historical facts and



1 LIGHT SLEEP
Half awake, half asleep. Eyes are closed but person can be easily awakened. Some experience sudden muscle contractions.

2 TRUE SLEEP
Breathing becomes regular. Body temperature and heart rate decrease as body prepares to enter deep sleep. This stage covers about half of adult sleep.

3 AND 4 DEEP SLEEP
Brain begins to produce slow delta waves. Heart rate is at its lowest level. Sleepwalking or sleep terrors can occur at this stage. Secretion of growth hormone increases significantly. Bones and muscle are built; tissues are regenerated.

Sources: Dr. Chun Bai, SUNY Downstate Medical Center; Dr. Subimal Datta, Boston University

dimes here; cello scales, jump shots and quarters over there. It then bundles them into readable chunks, at different times of the night. In effect, the stages of sleep seem to be specialized to handle specific types of information, the studies suggest.

On a recent Monday afternoon in Dr. Stickgold's lab at Beth Israel Deaconess Medical Center in Boston, a postdoctoral student, Matthew Tucker, was running a study of the effect of naps on memorized words. In a neighboring room, a Boston University student was cramming on a list of 48 word-pairs; in another, a stubbly University of Massachusetts student had finished studying and was reclining for a nap, his face covered with electrode patches, like leeches sprouting antenna.

"College students are always ready for nap; we have no problems there," Dr. Tucker was saying, as he moved back and forth, checking his watch, timing one student's nap and the other's study period.

I'm drinking heartbreak motor oil
and Bombay gin
I'll sleep when I'm
dead.

WARREN ZEVON

. . . . . .

Sleeping alone, except under doctor's orders, does much harm. Children will tell you how lonely it is sleeping alone. If possible, you should always sleep with someone you love. You both recharge your mutual batteries free of charge.

MARLENE DIETRICH

He sat down for a moment. "We are finding that if a person takes a nap that contains slow-wave sleep — deep sleep — that performance on declarative memory tasks, which require the memorization of fact-based information like word-pairs, is enhanced compared to a person who doesn't take a nap," Dr. Tucker said.

Previous studies of nocturnal sleep have found the same thing. Memory of learned facts, whether they are names, places, numbers or Farsi verbs, seems to benefit in part from deep sleep. Healthy sleepers usually fall into deep sleep about 20 minutes or so after head meets pillow. They might spend an hour or more in those lolling depths early in the night, and typically less time later on. When cramming on facts, in short, it may be wiser to crash early at night and arise early, than to burn the candle until 2 a.m., the research suggests.

REM sleep, the bulk of which comes later in the night, seems important for pattern recognition — for learning grammar, for example, or to bird-watch, or play chess.

In one 2003 study, Sara Mednick, then at Harvard and now at the University of California, San Diego, led a team that had 73 people come into the lab at 9 a.m. and learn to discriminate between a variety of textured patterns. Some of the participants then took a nap of about an hour at 2 p.m. and the others did not.

When retested at 7 p.m. the rested group did slightly better. When tested again the next morning, after everyone had slept the night, the napping group scored much higher. The naps included both REM and deep sleep.

"We think that a nap that contains both these states does about the same for memory consolidation as a night's sleep," when it comes to pattern recognition learning, Dr. Mednick said.

Not that Stage 2 is an empty corridor between destinations. In series of experiments that

he began in the early 1990s, Dr. Carlyle Smith of Trent University in Canada has found a strong association between the amount of Stage 2 sleep a person gets and the improvement in learning motor tasks. Mastering a guitar, a hockey stick or a keyboard are all motor tasks.

Musicians, among others, have sensed this for ages. A piece that frustrates the fingers during evening practice often flows in the morning. But only in recent years has the science caught up and given their instincts a practical shape.

For instance, Dr. Smith said that people typically got most of their Stage 2 sleep in the second half of the night. "The implication of this is that if you are preparing for a performance, a music recital, say, or skating performance, it's better to stay up late than get up really early," he said in an interview. "These coaches that have athletes or other performers up at 5 o'clock in the morning, I think that's just crazy."

A long — long Sleep
— A famous —
Sleep —
That makes no
show for Morn —
By Stretch of Limb
— or stir of Lid —
An independent
One —
Was ever idleness
like This?
Upon a Bank of
Stone
To bask the
Centuries away —
Nor once look up
— for Noon?

EMILY DICKINSON

For all these nighttime fireworks, memory researchers have yet to work out a complete picture of how all the pieces fit together. Each has a theory, but they differ: Dr. Smith focuses on Stage 2, others on deep sleep, still others on REM or a combination of REM and deep sleep. And no one knows how individual differences, between night owls and early birds, for instance, affect nighttime learning.

In addition, said Jerome Siegel, a professor of psychiatry at the University of California, Los Angeles, millions of people have taken drugs that suppress REM without reporting serious memory problems. "I wouldn't rule out the possibility that sleep contributes to learning and memory consolidation, but the claim is that it's essential, that it's doing something the waking brain won't, and the research hasn't shown that," Dr. Siegel said.

Even the college all-nighter provides evidence that some consolidation occurs during waking, he said. "College students know that the best way to learn stuff isn't to stay up all night because it's going to impair your judgment," Dr. Siegel said, "but it doesn't matter how good your judgment is if the information isn't in there. And students know from experience that a lot of it is."

One reason some neuroscientists are confident that the sleeping brain is actively working on the day's streaming video of information is because they have seen it with their own eyes — or heard it, at least.

In his lab at the Massachusetts Institute of Technology, Matthew Wilson has been studying rats and mice wearing what look like Carmen Miranda hats. These are ultralight implants through which researchers thread hairlike wires to record the activity of single cells deep in the brain, in the left and right hippocampus, where the day's memories are recorded.

Past research has shown that the hippocampus is spatially

sensitive: it seems literally to pair the firing of individual neurons with locations outside the body. These systems are thought to function in similar ways in humans and rodents.

Computers record the cells' firing in real time and can broadcast it over speakers. "I would listen to this background music of the brain sometime when the animals were asleep, and I started hearing this section that sounded very much like the pattern when the animals were in the maze," Dr. Wilson said in an interview. "I recognized the firing pattern."

The maze route is an important memory for these animals; it's about all they know. In a paper published last December, Dr. Wilson and Daoyun Ji reported that in sleeping animals they had recorded chatter in neurons in the visual center of the neocortex, followed by an apparent response in the hippocampus — and not just any response, but a replay of the activity in the hippocampus that occurred during a maze task.

I went to bed that night in the lonely hotel room. I could not sleep, and then, in the gray light between darkness and dawn, the words came to me line by line, stanza by stanza. I lay perfectly still, and the words came sweeping on with the rhythm of marching feet, pauseless, resistless. I saw the long line swinging into place before my eyes. I heard the voice of a nation speaking through my lips. Then when the last line was ended, I sprang from my bed and groping for pen and paper I scrawled in the gray twilight "The Battle Hymn of the Republic."

JULIA WARD HOWE, AS ADAPTED BY THE COMPOSER HENRY PAPALE

Dr. Wilson thinks of this as a kind of off-line conversation between the neocortex, which is involved in conscious learning during waking, and the hippocampus. "What we notice is that the light goes on in the neocortex a fraction of a second before it goes on in the hippocampus, as if the cortex is asking for information," he said.

He said that this process was probably similar to what goes on when people take a moment to reflect, without distractions, sifting through the experiences of the day, also flagging important details, replaying events. "The question is not whether this is an essential process; it is," Dr. Wilson said. "The question is whether there is something going on during this process that is unique to sleep."

Subimal Datta, a neuroscientist across the river at Boston University School of Medicine, thinks so. In his studies of animals, he has documented that during sleep the brain is awash in a chemical bath unlike any during waking. Levels of inhibitory transmitters increase sharply, and levels of many activating messengers drop, or shut down entirely.

In the sleeping brain, memories are first distilled and then sorted.

Even before REM is detectable, Dr. Datta said, a small pocket of cells in the brainstem spurs a surge in glutamate — an activating chemical — which leads to protein synthesis and other changes that support long-term memory storage.

"During waking we have a thousand things happening at once, the library is filling up, and we can't possibly process it all," Dr. Datta said. While awake the brain is also gathering lots of valuable information subconsciously, he said, without the person's ever being aware of it.

"It's during sleep that we have this special condition to clear

away this overload, and these REM processes then help store what's important," Dr. Datta said.

In the jargon of the field, the "signal to noise ratio" becomes much stronger. The neural trace of the trivia has weakened, and crucial details are replayed and reinforced.

Dreams still defy scientific measurement but they, too, have a place in the evolving theory of sleep-dependent learning.

It is likely during REM, some scientists argue, that the brain proceeds to mix, match and juggle the memory traces it has preserved, looking for hidden connections that help make sense of the world. Life experience is cut up and reordered, sifted and shuffled again. This process could account for the cockeyed, disjointed scenes that occur during dreams: the kaleidoscope of distilled experience is being turned.

It also might account for that golden gift often attributed to a night's sleep: inspiration.

To hear some people tell it, a night's sleep changed their world. It was reportedly during sleep that the Russian scientist Dmitri Mendeleev's periodic table of the elements tumbled into place. Friedrich August Kekule, a 19th-century chemist, said he worked out the chemical structure of the benzine ring — an important discovery — when he dreamed of a snake biting its tail. Athletes, including the golfer Jack Nicklaus, have also talked about insight coming during sleep.

Slight corrections in technique are revealed; sand traps are averted; mountains move.

"It does make sense these insights come during REM," Dr. Walker said. "I mean, what better time to play out all these different scenarios and solutions and ideas than in dreams, where there are no consequences?"

The problem, he and others say, is how to study it. That, most neuroscientists agree, will take some very creative thinking — both of the daytime and nighttime kind. □

Ask people to recall how many nightmares they had in the last year, said one dream researcher, and they might say one or two. Ask them to keep a dream diary, and they will report nightmares once or twice a month.

In the Dreamscape of Nightmares, Clues to Why We Dream at All

By NATALIE ANGIER

The patient was a 37-year-old man who had been physically abused as a boy by his schizophrenic mother, often while he lay in bed trying to fall asleep. Nevertheless, he had grown into a reasonably normal, gainfully employed adult, and he thought that the worst was behind him, until one night he awoke to find an intruder rummaging through his dresser drawers. After that, his nightmares began — terrifying, recurrent dreams in which the intruder was a middle-age woman and a knife dangled with Damoclesian contempt from the ceiling fan over his head.

"The old fear memories had not gone away," said Dr. Ross Levin, a psychologist and sleep researcher at Yeshiva University in New York. They "were

easily reactivated by the recent trauma," and just as readily twisted into the basis of a repetitive nightmare. Dr. Levin urged the patient to reframe the dream and rehearse alternatives to swinging blades and frozen fear, until finally the nightmares abated and the man could regain his footing.

Few of us suffer from nightmares crippling and persistent enough to demand treatment. Yet we all know how bad a nightmare feels, how it surrounds you and surges up to drown you and makes your teeth fall out in chunks and gives you leukemia and look, your 6-year-old daughter is running back and forth through traffic, and oh no, this train is headed the wrong way and it's past midnight, and there you are a cowardly third-grader back on Creston Avenue in the Bronx, no, please, not the Bronx! And you scream and you thrash and you want to wake up.

By all evidence, outrageously bad dreams are a universal human experience. Sometimes the dreams are scary enough to jolt the slumberer awake, in which case they meet the formal definition of nightmares — bad dreams that wake you up. At other times, they are even worse. The sleeper thinks the nightmare is over, only to step into Your Nested Nightmare, Chapter II. Whatever the particulars of the plot, researchers say, nightmares and dreadful dreams offer potentially telling clues into the larger mystery of why we dream in the first place, how our dreaming and waking lives may intersect and cross-infect each other, and, most baffling of all, how we manage to construct a virtual reality in our skull, a seemingly life-size, multidimensional, sensorily rich nocturnal roundhouse staffed with characters so persuasive you want to ... strangle them, before they can strangle you.

A big reason bad dreams offer insight into the architecture of dreams generally is that, as a host of studies have shown, most of our dreams are bad. Whether re-

search subjects keep dream journals at home or sleep in research labs and are periodically awoken out of rapid eye movement, or REM, sleep — the stage most often associated with dreaming — the results are the same: about three-quarters of the emotions described are negative.

Moreover, said Robert Stickgold, a sleep researcher at the Harvard Medical School, we are ridiculously industrious dreamers, spending 60 to 70 percent of somnolence dreaming or in a dreamlike state called sleep mentation, which works out to three hours nightly spent in a state of anxiety or frustration as we show up late for tests or walk barefoot over broken glass because our shoes have melted.

Even bona fide nightmares are more common than most of us realize. Ask people to recall spontaneously how many nightmares they had in the last year, and they might say one or two, said Mark Blagrove, a dream researcher at the University of Wales in Swansea. Ask them to

For many years, during the middle phase of my career, I'd wake up from a sound sleep with a good idea for an experiment. Sometimes it was a new way to interpret an experiment already done. This happened about two or three times a year. They were "out of the blue" moments and did not correspond to times I had been having dreams in the narrative sense.

I used to go back to sleep because it was too hard to get up. I mentioned this to my husband once. He got me a pad of paper on a tablet with a reading light attached to it.

keep a dream diary, and they will report nightmares once or twice a month.

Survey and diary studies have shown that nightmare frequency varies by age and sex. Preschoolers are relatively immune to the bogeyman fetish, but not so their elder siblings. Roughly 25 percent of children ages 5 to 12 report being awakened by bad dreams at least once a week.

Nightmare rates climb through adolescence, peak in young adulthood, and then, like so much else in life, begin to drop. The average 55-year-old has one-third the number of nightmares as the average 25-year-old. At nearly every age, girls and women report having significantly more nightmares than do boys and men, a fact that some researchers say may be related to women's comparatively higher rates of anxiety and mood disorders.

Nightmare content also shifts over time and across cultures. A young man in 21st-century America might not mind the oc-

I used that, and it was helpful. Then we moved from Chicago to the Boston area and I lost track of the lighted tablet. Now, I am "sleepstruck" less often, anyway.

SUSAN L. LINDQUIST, BIOLOGIST, HOWARD HUGHES MEDICAL INSTITUTE, M.I.T.

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I think the scientific evidence of problem-solving in sleep is nonexistent. For what it's worth, I've never had a scientific insight in my dreams. And I've been keeping a dream journal for 35 years.

J. ALLAN HOBSON, HARVARD SLEEP RESEARCHER

casional bawdy dream, but for St. Augustine, the fourth-century Christian philosopher, "sexual dreams were nightmares," said Kelly Bulkeley, a dream researcher and visiting scholar at the Graduate Theological Union in Berkeley, Calif. "He considered them threats to his faith."

Cultural specifics can also tweak universal themes. Dr. Bulkeley and his colleagues have found that nightmares about falling through the air are common among women in Arab nations, perhaps for metaphorical reasons. "There's such a premium in these countries on women remaining chaste, and the dangers of becoming a 'fallen woman' are so intense," he said, "that the naturally high baseline of falling dreams is amped up even more."

Using brain imaging devices that are noisy and uncomfortable and less than conducive to a good night's sleep, scientists have nonetheless begun identifying which regions of the brain are active during sleep and which are largely off-line. The brain proceeds through four stages of sleep at night, each characterized by its own pattern of brainwaves and neurochemical activity. REM sleep, when the eyes are flitting behind closed lids, is rightly renowned as the dreaming stage, with at least 90 percent of it spent dreaming. But dreams occur in parts of non-REM sleep, as well.

When slipping into REM sleep, Dr. Levin said, "the whole brain changes." "Neurochemically, it's like the Fourth of July," as cortical precincts shift colors in scanning images to indicate arousal or quiescence, he said, adding, "The limbic system becomes incredibly active, much more so than when you're awake, which is why you're emotionally on edge in dreams."

Blazing with particularly patriotic fervor in the limbic system are the amygdala and anterior cingulate cortex, constituting what Steven H. Woodward, a psychologist at the V.A. hospital in Menlo Park, Calif., terms the brain's "axis of fear." At the

same time, the prefrontal cortex, seat of rational thought and critical reasoning, is on lunch break, Dr. Levin said, "which is why you can have a dream where something has 4 heads and 12 legs, and you think, 'No problem, what's next?'"

Also relatively tranquilized is the primary visual cortex, recipient of visual signals from the outside world. The secondary visual cortex, however, which helps process and interpret those signals, remains alert. It is here that the fabulous imagery of dreams probably arises, said Tore Nielsen of the University of Montreal, as the secondary visual cortex strives to decipher the signals ricocheting through it, many of them internally generated, and to splice them into some approximation of a coherent whole.

Other sensory and motor systems remain active in REM, including those that would normally control the arms and legs, which is why motion figures prominently in many dreams. But if you often feel frustrated, as though you can

Once I, Chuang Tzu, dreamt that I was a butterfly, a butterfly flying about, feeling that it was enjoying itself. It did not know that it was Chuang. Suddenly I awoke and was myself again, the veritable Chuang. I do not know whether it was Chuang dreaming that he was a butterfly, or whether I am now a butterfly dreaming that it is Chuang.

CHUANG TZU,
THE 4TH CENTURY B.C.
TAOIST PHILOSOPHER

never get to where you're going, well, you can't.

As it happens, one vigilant player in dreaming is a small region of the brainstem that paralyzes most of the body, preventing you from physically acting out your dream. People with neurogenerative diseases that disable this brainstem disabler can end up injuring themselves during extreme dream-driven actions. Most cases of sleepwalking occur in non-REM sleep, when the body is not paralyzed.

With so much of the sleeping body and brain apparently colluding to allow us to wander safely through an ominous dreamscape of extravagant characters, most sleep scientists are convinced that dreaming serves an essential, possibly evolutionarily adaptive, purpose.

In a recent paper in Psychological Bulletin, Dr. Nielsen and Dr. Levin proposed that dreaming served to create what they call "fear extinction memories," the brain's way of scrambling, detoxifying and finally discarding old fearful memories, the better to move on and make synaptic space for any novel threats that may show up at the door. "The brain learns quickly what to be afraid of," Dr. Nielsen said. "But if there isn't a check on the process, we'd fear things in adulthood we feared in childhood."

Ordinary bad dreams rarely recapitulate unpleasant events from real life but instead cannibalize them for props and spare parts, and through that reinvention, Dr. Nielsen explained, the fears are defanged. "A bad dream that doesn't lead to awakening is successful in dealing with intense emotion," he said. "It's disturbing, but there is some kind of resolution to the extent we don't wake up."

By this scenario, nightmares, in allowing you to escape prematurely, represent a failure of the "fear extinction" system. "Bad dreams are functional, nightmares dysfunctional," he said.

If you feel yourself falling, spread your arms out and learn how to fly. □

American consumers spend $4.5 billion a year for sleep medications, but laboratory research has shown that sleeping pills in general do not greatly improve sleep for the average person —even though many people who take them say they are effective.

Sleep Drugs Found Only Mildly Effective, but Wildly Popular

By STEPHANIE SAUL

Your dreams miss you.

Or so says a television commercial for Rozerem, the sleeping pill. In the commercial, the dreams involve Abraham Lincoln, a beaver and a deep-sea diver.

Not the stuff most dreams are made of. But if the unusual pitch makes you want to try Rozerem, consider that it costs about $3.50 a pill; gets you to sleep 7 to 16 minutes faster than a placebo, or fake pill; and increases total sleep time 11 to 19 minutes, according to an analysis last year.

If those numbers send you out to buy another brand, consider this, as well: Sleeping pills in general do not greatly improve sleep for the average person.

American consumers spend $4.5 billion a year for sleep medications. Their popularity may lie in a mystery that confounds researchers. Many people who

take them think they work far better than laboratory measurements show they do.

An analysis of sleeping pill studies found that when people were monitored in the lab, newer drugs like Ambien, Lunesta and Sonata worked better than fake pills. But the results were not overwhelming, said the analysis, which was published this year and financed by the National Institutes of Health.

The analysis said that viewed as a group, the pills reduced the average time to go to sleep 12.8 minutes compared with fake pills, and increased total sleep time 11.4 minutes. The drug makers point to individual studies with better results.

Subjects who took older drugs like Halcion and Restoril fell asleep 10 minutes faster and slept 32 minutes longer than the placebo group. Paradoxically, when subjects were asked how well they slept, they reported better results, 52 extra minutes of sleep with the older drugs and 32 minutes with the newer drugs.

"People seem to be getting a lot of relief from sleeping pills, but does getting 25 minutes of sleep really give you all that relief?" asked Dr. Wallace B. Mendelson, the former director of a sleep disorders unit at the University of Chicago. "A bigger aspect of this is that they change a person's perception of their state of consciousness."

Dr. Mendelson is semiretired and is a consultant for pharmaceutical companies.

Dr. Karl Doghramji, a sleep expert at Thomas Jefferson Uni-

Most sleeping pills work on the same brain receptors as drugs to treat anxiety. By reducing anxiety, the pills may make people worry less about not going to sleep.

versity in Philadelphia, agreed. "Sleeping pills do not increase sleep time dramatically, nor do they decrease wake time dramatically," he said. "Despite those facts, we do find patients who, when they take them, have a high level of satisfaction." Dr. Doghramji has disclosed in the past that he is a consultant to pharmaceutical companies.

Most sleeping pills work on the same brain receptors as drugs to treat anxiety. By reducing anxiety, the pills may make people worry less about not going to sleep. So they feel better.

Another theory about the discrepancy between measured sleep and perceived sleep involves a condition called anterograde amnesia. While under the influence of most sleep medications, people have trouble forming memories. When they wake up, they may simply forget they had trouble sleeping.

"If you forget how long you lay in bed tossing and turning, in some ways that's just as good as sleeping," said Dr. Gary S.

My actual dreams do not appear to lead to productive insights and they are pretty standard: cops and robbers, missed trains, meetings where I am acclaimed or booed. A friend of mine once dreamed he was an elementary particle. Nothing came of it. As far as I can tell, lack of sleep impacts negatively on everything. My mantra, as far as scientific creativity is concerned:
Daydreaming is a must.
Night dreaming is a bust.

GINO C. SEGRE, HIGH-ENERGY PHYSICIST, UNIVERSITY OF PENNSYLVANIA

Richardson, a sleep disorders specialist at Henry Ford Hospital in Detroit who is a consultant and speaker for pharmaceutical companies and has conducted industry-sponsored research.

Sleep, after all, causes a natural state similar to amnesia, one reason toddlers often forget their violent nightmares by the next morning. If you stay in bed, as most people taking sleeping pills do, amnesia is not a bad thing.

Even some people who sleepwalked while taking Ambien, which was implicated in cases of odd, sometimes dangerous behavior while sleeping, believed they were having a good night's sleep. Rosemary Eckley, a graphic artist in New London, Wis., said she thought she was sleeping well on Ambien but woke to find her wrist broken, apparently in a fall while sleepwalking, she wrote in an e-mail exchange.

Reports of sleep-eating and sleep-driving on Ambien are reminiscent of problems nearly 20 years ago with Halcion. Some people who took that drug to sleep on airplanes developed a condition known as traveler's amnesia. They landed at their destinations, then got lost or forgot where they were, prompting the authorities in several countries to withdraw Halcion from the market.

Reports show that Ambien and similar drugs, advertised as safer than benzodiazepines like Halcion, can cause similar problems. The reports prompted the Food and Drug Administration to ask manufacturers to develop warning guides for distribution with virtually all sleep drugs. Despite such problems, most specialists say sleeping pills are generally safe. Dr. Mark W. Mahowald, director of the Minnesota Regional Sleep Disorders Center, which is involved in documenting cases of sleep-eating under the influence of Ambien, said serious side effects were rare and should not discourage the use of the pills.

The class of drugs known as nonbenzodiazepines, sometimes

called "Z" drugs, includes Ambien, Lunesta and Sonata. Ambien and its generic equivalent, zolpidem, are the most widely used, together accounting for 40 percent of the market.

Newer drugs like Lunesta and Ambien CR, a controlled-release formula, cost about $4 a pill. Zolpidem recently sold for $2 a pill on walgreens.com.

Of the three drugs in the class, Sonata, which also retails for about $3.50 a pill, remains in the body the shortest time and, therefore, is normally used by people who have trouble falling asleep but no problem staying asleep. The advocacy organization Public Citizen's Health Research Group says its benefits are so minimal it should not be used.

King Pharmaceuticals, the maker of Sonata, did not respond to several messages seeking comment.

A study by an Oregon State University group that reviews the safety and effectiveness of drugs found that Lunesta offered little benefit over generic Ambien or older benzodiazepines, but cost more. Jonae Barnes, a spokeswoman for Lunesta's maker, Sepracor, said the company strongly disagreed and added that the Oregon group did not adequately consider waking time after falling asleep, an area in which Lunesta performed better.

Users also sometimes report that Lunesta leaves a bad taste in their mouths, according to studies of the drug.

Dr. Mahowald said the older drugs, including Halcion, also known as triazolam, offered better value than the newer ones.

"We tend to use the old benzodiazepines," he said of his practice. "They appear to be as effective as some of the newer ones, and they're infinitely less expensive." Dr. Mahowald said that his center participated in industry-sponsored clinical research, but that he did not personally work as a consultant or adviser to pharmaceutical companies.

Such drugs, which include flurazepam, brand name Dalmane,

and temazepam, Restoril, sell in generic versions for 30 to 50 cents each.

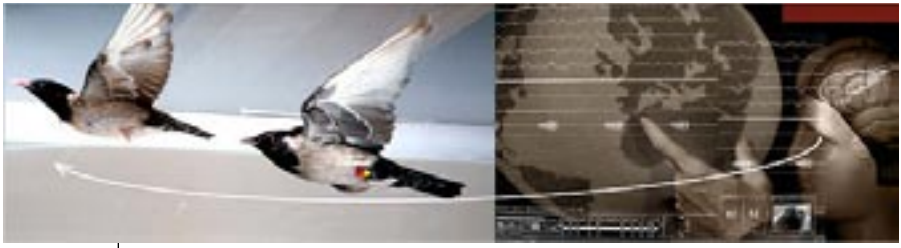
Another inexpensive alternative, and one of the most widely used sleep medications in this country, is the antidepressant trazodone. It works well in many patients, but some people say it leaves them groggy the next day, according to Dr. Daniel Carlat, a psychiatrist in Newburyport, Mass., who publishes The Carlat Psychiatry Report and declines industry financing. In men, trazodone has been linked to rare cases of priapism, prolonged and painful erections.

Some patients who fear using sleeping pills turn to over-the-counter remedies like Tylenol PM and Advil PM. Those contain the painkillers acetaminophen and ibuprofen combined with an antihistamine, diphenhydramine, the ingredient in the allergy medication Benadryl.

Antihistamines are known to make people sleepy, but there is little evidence that they improve sleep. They can also cause next-day sedation that impairs driving, as well as racing heartbeat and constipation. The Medical Letter, which reviews drugs, recommends against using antihistamines for sleep. Some doctors say users of Tylenol PM may be taking acetaminophen they do not need. Acetaminophen overdoses can cause liver failure.

Rozerem, with its unusual advertising campaign, has at least one benefit over other medications. Because it works by a different mechanism from the others, it is not a controlled substance and apparently does not affect the ability to form memories. It may be the sleeping pill of choice for elderly people who have trouble falling asleep, but suffer memory problems.

Still, researchers and drug companies have yet to find a holy grail. “The problem is, there is no ideal hypnotic,” said Dr. Manisha Witmans, a sleep medicine specialist at the University of Alberta’s Evidence-Based Practice Center. “The magic pill for sleep has not been invented yet.” □



Birds in a wind tunnel at the Max Planck Institute of Ornithology in Germany, where researchers tested a hypothesis that slow-wave sleep is essential in birds like it is in humans. Sriking parallels exist between bird and human sleep.

In Study of Human Patterns, Scientists Look to Bird Brains

By CARL ZIMMER

Last month, a bird known as a bar-tailed godwit took flight from Alaska and headed south. A day later, it was still flapping its way over the Pacific. An airplane pilot would have a hard time staying awake after 24 hours of flight (the Federal Aviation Administration allows pilots to fly just eight hours in a row). But the godwit kept flying for an additional week. After eight days and 7,200 miles, it landed in New Zealand, setting a record for nonstop flight.

"If they spend so many hours flying," said Ruth M. Benca of the University of Wisconsin, "where do they find the time to sleep?"

Bird sleep is so mysterious that scientists are considering several answers, all intriguing. The godwit may have managed to stay awake for the entire journey. Or it may have been able to sleep while flying. Or, as Dr. Benca and other scientists

suspect, its brain may have been in a bizarre state of semilimbo that they do not understand.

Bird brains produce patterns of electrical activity that look strikingly like human brains during sleep, a remarkable similarity considering that birds and their brains have been on a separate evolutionary course from mammals for 300 million years. But similarities reach just so far.

The amount of sleep birds need can change drastically through the year. Birds may be able to put parts of their brains to sleep while keeping others awake. They may be able to adjust sleep in the course of minutes, even seconds. By figuring out the mysteries of bird sleep, scientists hope to understand some universal rules of sleep.

Like humans, birds typically get some sleep every day. A pigeon usually sleeps through the night, for example, and has a few naps during the day. Why birds and mammals should sleep so much has long puzzled scientists. Some researchers have even ar-

About 25 years ago, I started to do something called "lucid dreaming." While you are dreaming, you choose to become aware of the fact that you're dreaming and to wake up within the dream. You become conscious within the dreamscape.

It's not easy. I tend to think of this as a way to get to parts of your consciousness that you don't ordinarily have access to. In the beginning, it's very scary. As you look around the dreamscape, things tend to morph and change in grotesque ways. So you have

gued that sleep is something that animals do when they have nothing else on their agendas.

Many sleep experts disagree. Something about sleep is essential to human well-being. It is possible that certain types of sleep are particularly important. In the course of a night's sleep, humans pass through distinct stages. In one stage, the eyes move rapidly behind closed lids while the brain produces electrical signals with a pattern much like that of a waking brain. It is during this so-called REM sleep that people experience dreams.

In other parts of sleep, however, many neurons produce electric signals with a nearly identical rhythm. The neurons also fire more slowly than in REM sleep, from 40 to 400 times a second. This dream-free sleep is so deep that it is hard to rouse people from it.

Several experiments suggest that slow-wave sleep, in particular, has a crucial role in human well-being. As neurons fire in synchrony, their connec-

to learn how to do it. You give quick glances. You don't dwell on one item.

In the dreamscape, there are people, characters. You talk to them. I sometimes ask them questions about my scientific problems. I've had some small victories, though I've never had a benzene ring. For example, in trying to track down the remaining undiscovered Alzheimer's genes, you come up with multiple candidates. One has to decide which should be investigated. I've asked, "Which is the better bet — gene A or gene B?"

tions change, consolidating the memories formed in the previous day. One sign of the importance of slow-wave sleep is that if people do not have enough of it, they catch up when they can, producing stronger waves.

"If you pull an all-nighter," Dr. Benca said, "the next night your slow waves will be much larger."

Other mammals experience REM sleep and slow-wave sleep, as well, indicating that humanlike sleep patterns existed early in the history of mammals. But beyond mammals, scientists have had a hard time finding humanlike sleep patterns. So far, they have been seen just in birds. The fact that the closest relatives of birds, like alligators and turtles, do not have our kind of REM sleep and slow-wave sleep suggests that birds, or their dinosaur ancestors, evolved humanlike sleep independently.

This parallel evolution has given scientists the opportunity to test the hypothesis that slow-wave sleep is essential. "If slow-wave sleep is a fundamental building block of sleep, then it

Half the time, the character gives you a strange look and then you wake up. Sometimes, they'll clearly say, "B." Now, I won't go back to the lab and say, "Aha, B is it!" But I may spend some extra time on the Web looking into publications about gene B. It's a way of tapping into my intuition.

RUDY TANZI, ALZHEIMER'S INVESTIGATOR, HARVARD

should be true in birds as well as in mammals," Dr. Benca said.

Niels Rattenborg of the Max Planck Institute of Ornithology in Germany tested this hypothesis by depriving pigeons of some slow-wave sleep. "We kept pigeons from taking their daytime naps," he said. "All we did was tap their cage or move the cage floor or give them things to play with for eight hours before we turned the lights off."

After the lights went dark, the pigeons had slow waves 27 percent stronger than on undisturbed nights. "What we found was that they actually showed response very much like that observed in mammals," Dr. Rattenborg said. "There's something in common in being a bird and being a mammal that results in sleeping this way."

Dr. Rattenborg contends that birds and mammals have similar kinds of sleep because birds and mammals have much larger and more complex brains for their size than other vertebrates. In mammals, much of that expansion occurred in the front of the brain, in the neocortex. The neocortex endows mammals with sophisticated, flexible learning and decision making.

Only in recent years have scientists realized that birds have a brain region similar to the mammal neocortex. Known as the pallium, it arises from the same population of embryonic cells that produces the neocortex in mammals.

The pallium is made up of clumps of neurons, while the neocortex is organized in layers. Despite the differences, the pallium also lets birds carry out many impressive mental tasks. Some birds can remember thousands of locations where they hide food. Others fashion tools like sticks, to obtain food. Others can learn many bird songs. Pigeons can learn how to distinguish between Cubist and Impressionist paintings.

Dr. Rattenborg proposes that big, powerful brains need the same kind of slow-wave sleep to work properly, whether those brains are in birds or mammals.

"If we didn't have birds," he

said, "people might say, 'Well a neocortex is absolutely necessary.' But here we have birds doing the same thing. So clearly, it's not having the neocortex that's essential."

Although the parallels between sleep in birds and humans is striking, they extend just so far. A bout of slow-wave sleep in a human may last for hours. In birds, a normal period may last a few minutes, even a few seconds. "You and I can't sleep in 10-second bouts," Dr. Benca said.

Dr. Rattenborg has found that birds can also keep one side of their brain awake while the other sleeps. He suspects that the awake half can keep a lookout for predators while the other half sleeps.

Dr. Benca suspects that birds may be able to make smaller parts of their brains go to sleep or wake up.

"Maybe," she said, "we need to get away from thinking of sleep as something you have to do for so many minutes, and if the whole brain isn't doing something that looks like sleep, then sleep isn't happening. I think their brains are doing something else."

Part of Dr. Benca's hunch comes from her difficulty in keeping birds awake. Working with Dr. Rattenborg and other colleagues, she tried to deprive pigeons of sleep. The researchers put pigeons on a circular platform over a tank of water. When the pigeons produced slow waves for four seconds or more, the platform began to turn slowly, so that they had to walk.

In humans and other mammals, sleep deprivation eventually causes weight loss, hunger and other symptoms. It can even lead to serious illnesses. But pigeons showed none of those changes, as Dr. Benca and her colleagues will report in a paper to be published in Physiology and Behavior.

Birds have apparently evolved an ability that many humans would envy.

"We could deprive the pigeons for weeks," Dr. Benca said, "and they seemed to be doing fine." □

The Elderly Always Sleep Worse, And Other Myths of Aging

By GINA KOLATA

As every sleep researcher knows, the surest way to hear complaints about sleep is to ask the elderly.

"Older people complain more about their sleep; they just do," said Dr. Michael Vitiello, a sleep researcher who is a professor of psychiatry and behavioral sciences at the University of Washington.

And for years, sleep scientists thought they knew what was going on: sleep starts to deteriorate in late middle age and steadily erodes from then on. It seemed so obvious that few thought to question the prevailing wisdom.

Now, though, new research is leading many to change their minds. To researchers' great surprise, it turns out that sleep does not change much from age 60 on. And poor sleep, it turns out, is not because of aging itself, but mostly because of illnesses or the medications used to treat them.

"The more disorders older adults have, the worse they sleep," said Sonia Ancoli-Israel, a professor of psychiatry and a sleep researcher at the University of California, San Diego. "If you look at older adults who are very healthy, they rarely have sleep problems."

And new studies are indicating that poor sleep may circle back to cause poor health. At least when it comes to pain, a common cause of disrupted sleep, a restless night can make pain worse the next day. Then with worse pain, sleep may become even more difficult — a vicious cycle common in people with conditions that tend to afflict the elderly, like back pain and arthritis.

The new view of sleep emerged from two parallel lines of research. The first asked what happened to sleep patterns when healthy people grew old. The second sought to uncover the relationship between sleep and pain.

To find out what happens with aging, some investigators, including Dr. Vitiello, studied older people who reported no sleep problems. They actually make up a large group — nearly half of people over 65. Were these people somehow spared age-related changes in sleep?

They were not. Their sleep turned out to be different from sleep in young people: it was lighter, more often disrupted by brief awakenings, and shorter by a half hour to an hour. Dr. Vitiello reasoned that the age-related changes in sleep patterns might not be an issue in themselves. Something else was making people complain about their sleep.

Dr. Vitiello and his colleagues also asked what normally happened to sleep over the life span. It had long been known that sleep changes, but no one had systematically studied when those changes occurred or how pronounced they were in healthy people.

With analysis of 65 sleep studies, which included 3,577 healthy subjects ages 5 to 102, the investigators had their next surprise. Most of the changes in sleep patterns occurred when people were between the ages of 20 and 60. Compared with teenagers and young adults, healthy middle-aged and older people slept a half hour to an hour less each night, they woke up a bit more often during the night, and their sleep was lighter. But after age 60, there was little change

Pain affects sleep, of course. But new research shows how the lack of sleep affects pain.

in sleep, at least in people who were healthy.

And even though sleep changed during adulthood, many of the changes were subtle. Middle-aged and older people, for example, did not have more difficulty falling asleep. The only change in sleep latency, as it is called, emerged when the investigators compared latency at the two extremes, in 20- and 80-year-olds. The 80-year-olds took an average of 10 more minutes to fall asleep.

Contrary to their expectations, the investigators found no increase in daytime drowsiness in healthy older people. Nor did aging affect the time it took for people to start dreaming after they fell asleep.

Instead, the biggest change was the number of times people woke after having fallen asleep.

Healthy young adults sleep 95 percent of the night, said Dr. Donald Bliwise, a sleep researcher at Emory University. "They fall asleep," he said, "and don't wake up until the alarm goes off."

By age 60, healthy people are asleep 85 percent of the night. Their sleep is disrupted by brief wakeful moments typically lasting about 3 to 10 seconds. "There is some aspect of sleep that isn't going to be as good as when you were 20," Dr. Bliwise said. But he added, "When that crosses the threshold and becomes a significant complaint is difficult to say."

The real sleep problems, he and others say, arise when people have any of a number of conditions that make them wake up in the night, like sleep apnea, chronic pain, restless leg syndrome or urinary problems. That, of course, describes many older people.

"The sheer number of challenges to maintaining solid sleep in old age is just huge," Dr. Bliwise said. "You come out with the question, Well, what is normal? What should I expect?"

The new frontier of what to expect, and what to do about it, involves studies of the relationship of sleep to pain. It's no sur-

prise that pain can disrupt sleep. But what is new is that a lack of sleep can apparently increase the sensation of pain.

Michael T. Smith, the research and training director of the behavioral sleep medicine program at Johns Hopkins School of Medicine, reached that conclusion with a study of healthy young people. One group slept normally for eight hours in the hospital. Another was awakened every hour by a nurse and kept up for 20 minutes. Their sleep pattern was meant to mimic the fragmented sleep of elderly people. A third group was allowed four hours of solid sleep.

Comparing the second and third groups allowed Dr. Smith to tease apart the causes of the problems that arise from fragmented sleep: were they because of the short total sleep time, or because of the disrupted nature of the sleep?

Fragmented sleep, he found, led to severe impairments the next day in pain pathways. The subjects felt pain more easily, were less able to inhibit pain, and even developed spontaneous pain, like mild backaches and headaches.

Timothy Roehrs, director of research at the sleep disorders research center at Henry Ford Hospital in Detroit, also found that healthy young people became exquisitely sensitive to pain after a night of fragmented sleep.

And getting more sleep, Dr. Roehrs found, had the opposite effect. His subjects were young healthy people who said they were chronically sleepy, just not getting enough time to sleep at night. Dr. Roehrs had them stay in bed 10 hours a night. The extra sleep, he said, reduced their sensitivity to pain to the same degree as a tablet of codeine.

Now, Dr. Smith says, he and others have markedly changed their attitude about sleep problems and aging.

Of course, he said, sleep is different in 20-year-olds and 70-year-olds. But he added, “It’s not normal to get a clinical sleep disorder when you get old.” □

In his sleep studies, Dr. Emmanuel Mignot has moved his focus to zebrafish after years of studying more cooperative narcoleptic dogs. Scientists know that narcolepsy arises from a deficiency in brain cells that produce the protein hypocretin.

SCIENTIST AT WORK | Emmanuel Mignot

From Faithful Dogs and Difficult Fish, Insight Into Narcolepsy

By INGFEI CHEN

On a sun-drenched morning this month, a small, black, bushy-haired dog trotted out from the animal care center at Stanford. The Belgian schipperke, Bear, soon veered off to lift a hind leg over a shrub.

He was, clearly, oblivious to the gravitas of the day. Bear had spent nearly seven years in the underground kennels as part of a colony of narcoleptic dogs studied by Dr. Emmanuel Mignot, director of the Stanford Center for Narcolepsy.

Dr. Mignot had just signed papers to adopt the dog, the last of the colony. Bear's freedom ended 30 years of investigations that led to the discovery of the importance of a neurochemical called hypocretin in human and animal narcolepsy, and in normal sleep.

Bear will now be a pet. And Dr. Mignot has turned to less huggable research subjects, like wet, cold-blooded and, unexpectedly, less cooperative zebrafish.

Investigators now understand that narcolepsy arises from a deficiency of the brain cells that make hypocretin, similar to the way that Parkinson's is caused by the loss of dopamine-producing neurons.

Dr. Mignot, who has devoted his career to studying narcolepsy, has been "a real pioneer in this," said Giulio Tononi, a sleep researcher at the University of Wisconsin, Madison. Pivotal contributions also came independently from scientists in Dallas and Los Angeles.

The normal boundaries between wakefulness and slumber fray in narcolepsy, which plagues 135,000 Americans. Symptoms include overwhelming sleepiness during the day, insomnia at night and hallucinations or muscle paralysis while dozing off. Laughter or strong emotions like elation and anger can set off sudden muscle weakness. One good joke, and patients can find their knees buckling or heads sagging. But they remain awake.

In the early 1970s, a sleep scientist at Stanford, William C. Dement, diagnosed narcolepsy in a French poodle. He tracked down Doberman pinschers and Labrador retrievers with an inherited form of the disorder, establishing a breeding colony in 1976. The dogs shared a striking trait: collapsing in attacks of muscle weakness when excited by their favorite food.

Dr. Mignot began studying the colony in 1986. Born in Paris, he received his M.D. from the René Descartes School of Medicine in 1984, in tandem with doctorate pharmacology studies at Pierre and Marie Curie University. After a psychiatry residency, he faced a year of mandatory military training, or he could practice medicine for 16 months in Africa or Asia.

Dr. Mignot, who said he was "a nerd of the greatest dimension," sought a different path. Intrigued by the enigma of sleep,

he persuaded a French company to send him to Stanford to test its experimental narcolepsy drug on the dogs. Dr. Mignot arrived in Palo Alto, Calif., in 1986.

The medication, modafinil, reduced sleepiness but had no effect on paralysis attacks, Dr. Mignot found. In 1988, he became head of the Center for Narcolepsy and decided to hunt for the canine narcolepsy gene. "At that time," he recalled, "there were no maps of the dog genome."

It took 10 years and breeding nearly 200 Doberman and Labrador puppies to succeed, working with a psychiatry professor, Dr. Seiji Nishino, and others. (Animals were later put up for adoption.)

In August 1999, Dr. Mignot's team announced the culprit: a flawed gene for a receptor protein that binds to hypocretin. In a surprise, Dr. Masashi Yanagisawa, a geneticist at the University of Texas Southwestern Medical Center, reported that month that deleting the gene for hypocretin caused narcolepsy in mice.

Those dreams that
on the silent night
intrude,
And with false flit-ting
shapes our minds
delude,
Jove never sends us
downward from the
skies,
Nor do they from
infernal mansions
rise;
But all are mere
productions of the
brain.
And fools consult
interpreters in
vain.

JONATHAN SWIFT, "ON DREAMS"

• • • • • • • • •

Follow your dreams, except for that one where you're naked at work.

ATTRIBUTED TO HENNY YOUNGMAN

Those genes are normal in most human narcoleptics but they still lack hypocretin, according to separate studies by Dr. Mignot's group and a team led by Jerome Siegel, a neuroscientist at the University of California, Los Angeles. The reason is that patients have lost 90 percent of the brain cells that make hypocretin.

In a report in May, Dr. Siegel said that in late-stage Parkinson's disease, as well, the hypocretin-producing cells were missing, 62 percent of them. Daytime drowsiness and poor night sleep are common in Parkinson's patients. "Long before they're diagnosed," Dr. Siegel said, "these individuals are sleepy."

Hypocretin was the first protein directly linked to a true sleep disorder, and many labs jumped into deciphering its role in normal sleep. "I think hypocretin is a key molecule that helps you stay awake when you start to be sleep deprived," Dr. Mignot said.

Scientists know that a small set of hypothalamus neurons secrete hypocretin, activating brain circuits to promote wakefulness. Research also suggests that hypocretin is involved in regulating muscle tone, metabolism and feelings of pleasure.

Initial hopes for improved narcolepsy medicines that replace hypocretin faded.

Initial hopes for improved narcolepsy medicines that replace hypocretin have faded, because studies showed that the molecule did not readily cross the blood-brain barrier. It may be possible to find an oral hypocretinlike drug, Dr. Mignot said. Many patients rely on modafinil, approved in 1999, and other stimulants. To suppress paralysis, patients take antidepressants or sodium oxybate, found in the date-rape drug. None of the medicines influence the hypocretin system.

Dr. Mignot is now asking why hypocretin neurons die in narco-

leptic people. The best hypothesis is that the immune system destroys the cells, but no one has direct evidence of that, Dr. Mignot said.

His group has been studying rodents, tinkering with genes in their hypocretin cells to see whether damage or symptoms result. But diagnosing narcolepsy in mice is tricky. "Sometimes," he said, "they collapse, but you don't really know why."

He has turned to zebrafish, which possess hypocretin and hatch rapidly. Computer analyses of fish videos convinced him that the animals do sleep. Snoozing fish drift to the tank bottom and stop. "Their tail kind of droops," he said.

In a study published last week in PLoS Biology, the researchers reported on an effort to breed a colony of narcoleptic zebrafish by obtaining mutant fish that lacked hypocretin receptors. "I was hoping that they would collapse, like the dogs," Dr. Mignot said. But the fish did not flop over. They were no sleepier during the day, and they were evening insomniacs.

Their hypocretin cells, it turns out, are not wired like those in mammals. Dr. Mignot concluded that zebrafish would not open major insights into hypocretin's role in narcolepsy; the sleep system "is just very different."

Although disappointed by the findings, Dr. Mignot mused that one could learn as much from negative results as from positive. He still plans to explore the cell biology of zebrafish hypocretin neurons.

By studying fish and other animals, Dr. Mignot said and Dr. Siegel agreed, researchers could reap knowledge about the evolution of sleep across species.

Dr. Mignot is optimistic about cracking the immune-system connection in narcolepsy soon. "I don't care actually even if it's going to take a long time," he said. "I'm ready to cross deserts."

Dr. Tononi said Dr. Mignot was ideally suited for that, adding: "This is what is good about Mignot. He is relentless." □

PERSONAL HEALTH

At Every Age, Feeling The Effects Of Too Little Sleep

By JANE E. BRODY

For decades, I assumed I needed to sleep just five to six hours a night. I nearly always awoke before the alarm in the morning. But I also nearly always fell asleep at concerts and plays, on the subway or while reading or riding in a car.

Last summer, when I was able to operate completely on my body's own time clock, I discovered that it preferred seven to seven and a half hours of sleep. I also discovered that when I slept at night for however long my body wanted to, my daytime dozes all but disappeared.

Surveys have shown that few of us past infancy and toddlerhood are receiving the amount of sleep our bodies and brains need to restore them to full function for the day ahead. And many of us — children, teenagers and adults of all ages — may pay a hefty price.

As noted elsewhere in this issue, crucial brain functions occur in sleep that cannot be reproduced when we are awake.

More than intellectual prowess can suffer; though definitive data are still lacking, a chronic shortage of sleep has been linked to serious physical ills, including heart disease, diabetes and obesity.

From infancy to adulthood, there are marked changes in how much sleep people need each day, the amount of time spent in each stage of sleep and how easily they fall asleep and stay asleep, a factor scientists call sleep efficiency.

Newborns sleep 16 to 18 hours a day, though rarely more than four hours at a time. They awaken to be fed and changed, then soon return to slumberland.

By about 3 months, the time Dr. Richard Ferber suggests parents should try to enforce a more reasonable sleep schedule, babies' sleep patterns begin to respond to circadian rhythms of day and night. Year-old infants typically sleep 10 to 12 hours a night and nap 3 to 5 hours during the day.

The amount of sleep children need decreases gradually with age; preschoolers need 10 to 12 hours. By age 6, a tendency to be a lark or a night owl emerges, the latter often leading to havoc on schooldays, when children have to be awakened earlier than their body clocks dictate.

Sleep deprivation seems to start early. A 2004 survey by the National Sleep Foundation found that on average, children in every age group from infancy through fifth grade failed to get even the low end of the recommended range of sleep.

The real agony emerges in adolescence. As children go through puberty, two things happen to make getting enough

Even toddlers don't get enough rest. But the real agony starts in the teens.

sleep problematic: they need more sleep than prepubescent children, not less — 9 to 10 hours a night — and their body clocks shift to a later time to fall asleep and, consequently, a later awakening.

Amy R. Wolfson, a psychologist at the College of the Holy Cross in Worcester, Mass., and Mary A. Carskadon, a sleep researcher at the Brown School of Medicine in Providence, R.I., have found that few adolescents sleep the amount they need. The average eighth grader sleeps less than eight hours, and more than a quarter of high school and college students are chronically sleep deprived, they reported.

In a report last February in the journal Pediatrics, researchers from the Columbia University School of Nursing estimated

that "15 million American children are affected by inadequate sleep." They based this on the findings of a national health survey in 2003 of 68,418 children ages 6 to 17. In the study, by Arlene Smaldone and colleagues, the percentage of children who failed to sleep enough rose with age and increased markedly among children 12 and older.

Sleep deprivation has been linked to poorer grades, moodiness and depression. Though you may question which comes first, Avi Sadeh, a psychologist at Tel Aviv University, studied the effects of adding or subtracting one hour of sleep on 77 children in the fourth and sixth grades. Those deprived of an hour's sleep performed less well on tests for reaction time, recall and responsiveness than the children who slept the extra hour.

Insufficient sleep in the teenage years has been associated with increased risks of disciplinary problems, sleepiness in class and poor concentration, not to mention traffic accidents.

With televisions and computers in their rooms, many teenagers cannot resist the temptation to stay up late, especially because their bodies do not begin to produce the sleep hormone melatonin until 1 a.m., as opposed to 10 p.m. in most adults.

Then there is the problem of school starting times. Many teenagers have to leave for school before 7 a.m. to be in class by 7:30.

A study of more than 7,000 high school students in Minnesota showed that when some schools switched their starting time to 8:40 a.m. from 7:15, students had more sleep on school nights, were less sleepy during the day, earned slightly higher grades and experienced fewer depressive feelings and behaviors than students in schools that kept early starting times.

By contrast, Dr. Carskadon wrote, in a school that switched its starting time to 7:20 from 8:25, nearly half the students were "pathologically sleepy" at

8:30. “These early school start times are abusive,” she wrote.

Dr. Ronald E. Dahl, a sleep expert at the University of Pittsburgh, says sleep deprivation among teenagers creates a “negative spiral” of fatigue, emotional instability, poor decision making and risky behavior. Dr. Dahl and others agree that long-term studies of the effects of sleep deprivation in the teenage years are desperately needed.

Harmful effects on adult health have been associated with sleeping too little and with sleeping too much, though what constitutes too little and too much varies from study to study.

Studies suggest that adults who sleep seven to eight hours a night are the healthiest. About a third fall into that range. More than a third sleep less than seven hours, and nearly a third sleep more than eight hours.

A six-year study of more than one million adults ages 30 to 102 by researchers at the University of California, San Diego, and the American Cancer Society found the highest mortality rate among those who slept less than four hours or more than eight hours a night. The study took into account factors like age, diet and exercise and risk factors like smoking.

The lowest death rates were found among those who averaged six to seven hours of sleep.

The lowest death rates were found among those who averaged six to seven hours of sleep.

Although the lead researcher, Dr. Daniel F. Kripke, now an emeritus professor, could not explain the findings, studies have found that people who sleep the least or the most are more likely to have high blood pressure, symptoms of depression or heart disease. Sleep deprivation can also inhibit the body’s ability to produce insulin

and increases the risk of diabetes.

In the Nurses' Health Study, Dr. Najib T. Ayas, then at Brigham and Women's Hospital in Boston, found that among 71,617 women followed for 10 years, long and short sleepers both faced increased risk of heart disease. Dr. Ayas, now at Vancouver General Hospital, reported that women who slept eight hours a night had the lowest risk.

In another finding among the nurses, those who slept nine or more hours a night were twice as likely to develop Parkinson's disease as those who averaged six hours or less. This study, by scientists at the National Institutes of Health, tracked 80,000 nurses, all initially free of the disease, for 24 years.

Though it seems counterintuitive (more time spent out of bed should burn more calories), people who sleep less tend to weigh more. After adjusting the data for all sorts of potentially confounding factors, researchers who studied 990 employed adults in rural Iowa found that the less sleep they received on weeknights, the higher their body mass index.

That finding was consistent with the relationship of sleep to weight found in other settings, in children as well as adults.

Dr. Shahrad Taheri of the University of Bristol in England noted that in a long-term British study, "short sleep duration at an early age of 30 months predicts obesity at age 7." Dr. Taheri suggested last year in The Archives of Disease in Childhood that sleep loss in toddlers might change brain mechanisms that regulate appetite and energy expenditure.

In the Wisconsin Sleep Cohort Study, short sleep duration was associated with low levels of leptin, a hormone that signals the need for more calories. In addition, short sleepers had higher levels of the hormone ghrelin, which is released mainly in the stomach at highest levels before meals and has been shown to increase food intake. □

In most of the world, sleeping next to your child is a necessity. But in the West, the practice is widely frowned on by grandparents, friends and the medical community. Still, studies have shown it is more common than many people think.

WELL

Shhh...My Child Is Sleeping (In My Bed, Um, With Me)

By TARA PARKER-POPE

A few years ago, my daughter told me about a dream involving a giant bag of Doritos. The crinkles in the package had formed a sort of ladder, and she had climbed them to reach the giant chips inside. “It was such a good dream, Mom,” she told me.

The Doritos dream is just one of the countless parent-child memories that I have experienced in the middle of the night. Since she was an infant, my daughter, now in the third grade, has shared my bed and my sleep. I certainly never expected to be a “co-sleeping” parent, but sharing a bed was simply easier when she was a baby still breast-feeding, and getting her out of the bed as she got older has been next to impossible.

In most of the world, sleeping next to your child is a necessity: families of limited means live

in cramped quarters. But in the affluent West, the practice is widely frowned on, not just by grandparents and friends, but by the medical community at large.

Still, it is far more common than many people think. Nearly 13 percent of parents in the United States slept with their infants in 2000, up from 5.5 percent in 1993, according to a report last month in the journal Infant and Child Development. Countless children start the night in their own beds, only to wake up a few hours later and pad into their parents' bedrooms, crawling into the bed or curling up nearby on the floor.

Ask parents if they sleep with their kids, and most will say no. But there is evidence that the prevalence of bed sharing is far greater than reported. Many parents are "closet co-sleepers," fearful of disapproval if anyone finds out, notes James J. McKenna, professor of anthropology and director of the Mother-Baby Behavioral Sleep Laboratory at the University of Notre Dame.

"They're tired of being censured or criticized," Dr. McKenna said. "It's not just that their babies are being judged negatively for not being a good baby compared to the baby who sleeps by himself, but they're being judged badly for having these babies and being needy."

For 'closet co-sleepers,' revealing the truth isn't worth the criticism.

In fact, research shows that parents often talk about their children's sleep habits in terms of where the child starts off the night or where the child is supposed to sleep — not necessarily where the child usually ends up sleeping.

In a series of studies in Britain, scientists interviewed parents about their children's sleep habits, but also used infrared cameras to monitor the parents' bedroom. The children often spent part of the night in the adults' bed, but in about half those cases, the parents did not reveal that unless

they were specifically asked. As a result, many experts say most of the data in the United States vastly understates how common the practice really is.

One reason may be that adults feel guilty because pediatricians frown on co-sleeping. The American Academy of Pediatrics has said babies should sleep close to their parents but not in the same bed. The concern is that a sleeping parent could trap a baby in bed covers or in the space between the bed and the wall.

Although some studies suggest bed sharing puts children at higher risk for sudden infant death syndrome, the data are not conclusive. And some researchers say the risk is higher only if parents smoke, drink too much alcohol and fail to take proper precautions to make sure the bed is safe.

One common concern is whether the practice interferes with the development of healthy sleep habits. For example, studies in Italy, China, the United States and elsewhere have consistently found links between co-sleeping

O sleep! O gentle sleep!
Nature's soft nurse, how have I frighted thee
That thou no more wilt weigh
mine eyelids down
And steep my senses in forgetfulness?

SHAKESPEARE, "HENRY IV, PART 2"

• • • • • • • • •

There will be sleeping enough in the grave.

BENJAMIN FRANKLIN

• • • • • • • • •

It is a common experience that a problem difficult at night is resolved in the morning after the committee of sleep has worked on it.

JOHN STEINBECK

and frequent night wakings.

But the studies are generally based on reports from the parents themselves, and some researchers question whether such data are all that meaningful. Kathleen Dyer, an assistant professor of child, family and consumer sciences at California State University, Fresno, says this measurement bias may lead scientists to overstate the problems associated with bed sharing.

In one study, for example, 139 parents were asked about the sleep habits of their young children. Parents who slept with their children reported a much higher frequency of nighttime wakings than parents who did not.

Of course, Dr. Dyer says. "When you're sleeping with your kid and he wakes up once during the night, you know about it because you're there," she said. "If he's in the next room, he's still waking up at night, but you just don't see it." The more important question, she says, is whether the parents regard nighttime wakings as a problem. "What the researcher thinks is a problem," she said, "is often not what the family thinks is a problem."

Another fear is that bed sharing will take a heavy toll on a marriage. That is certainly likely if the parents disagree about where a child should sleep. But in cases where both parents agree on the sleeping arrangement, parents who sleep with their children are typically as happy as parents of solitary sleepers.

In a paper last month in Infant and Child Development, Dr. Dyer proposed that co-sleeping families fall into three distinct categories. There are intentional co-sleepers — those who sleep with their children because they want to breast-feed for a long stretch and believe bed sharing is good for a child's well-being and emotional development. Another group is reactive co-sleepers, those parents who don't really want to sleep with their kids, but do so because they can't get their children to sleep any other way or because financial hardship requires them

to share a room with a child.

And then there is a third group that she tentatively calls circumstantial co-sleepers—parents who sleep with their children occasionally because of circumstances like sharing a bed on a family vacation, during a thunderstorm or because the child is sick.

Bed sharing is most likely of greatest concern among reactive co-sleepers, Dr. Dyer says, because the practice is essentially forced on parents. In those cases, the practice is likely to be stressful for both parent and child.

"I think it's possible to sleep next to a baby and not be responsive to their tender needs," Dr. Dyer said. She recalled a story of a mother who was temporarily living with her in-laws and sharing a room with her child. "I think she was resentful of the fact that they were crammed into this room," she went on. "Where a person sleeps is not what it's about. It's about the quality of the emotional relationship."

When my daughter was born, I certainly didn't want her in my bed. (I was recovering from a Caesarean section.) But the nurses insisted that I hold her in my hospital bed because her cries were disturbing the other babies. I didn't have the fortitude to let her "cry it out," so with the encouragement of my pediatrician, I made my peace with the situation.

"You just have one of those babies who needs to be held," he said.

It hasn't always been easy. A friend of mine correctly notes that sleeping with a child is much like sleeping inside a washing machine. But today, my daughter is far more independent about sleep, venturing to sleepovers at friends' houses, staying overnight at camp and sleeping some nights in her own bed.

And while there are still many nights when she crawls into bed next to me, my pediatrician assures me it's nothing to worry about.

"I can tell you with certainty," he says, "that one day you will wake up, and she won't be there." □