

Adolescents and Sleep

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In making "Inside the Teenage Brain," we seemed to hit a nerve -- a parental one -- when we began looking into the world of teenagers and how they sleep. The patterns that young teens seemed to be experiencing -- an inability to go to sleep at night, followed by profound drowsiness on waking -- seemed so pervasive that it should come as no a surprise that what parents were seeing at home had already been corroborated in university sleep labs at Stanford and Brown.

Reseachers had always believed that sleep was governed by what was called the sleep-wake homeostasis, that is: "All other things being equal, ... the longer one is awake, the greater the pressure for sleep to occur. ... This process accounts for the increased need for sleep after staying awake all night." [1] It seemed perfectly reasonable that people would want to sleep when they were very tired. But it didn't account for a number of patterns that were obvious outside the lab: jet travellers woke up at 2 a.m. despite being exhausted after flying from Boston to London, teenagers had trouble falling asleep though they also seemed to be very tired, older people often woke up very early in the morning.

The Biological Clock

What researchers discovered is an internal biological clock, a clock that sometimes acts against the sleep-wake cycle by keeping us alert when we should be feeling tired. Sleep researchers [Mary Carskadon](#), now at Brown University, and Bill Dement at Stanford had seen this biological clock in action when they tested a group of 10-12 year olds at Stanford. Dement, who pioneered sleep research at Stanford, wrote about these experiments: "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 by the surprising result that after 12 hours of being awake, the subjects were *less* sleepy than they had been earlier in the same day, and at the 10 o'clock test, after more than 14 hours of wakefulness had elapsed ...they were even less sleepy." [2]

The researchers found that the biological clock opposed the sleep-wakefulness cycle at certain points of the day and at certain ages. It kept people awake when they were very tired. Just before puberty, that internal clock helped teens stay alert at night when they should have been falling asleep. The researchers called this a "phase-delay."

The biological clock or circadian rhythms (from the Latin words "circa" and "dies," or "around day") of smaller children don't show the same delays. Nothing is opposing their need to sleep in the evening. Until the age of 10, many children wake up fresh and energetic to start the day. In contrast, the biological clock of pre-teens shifts forward, creating a "forbidden" zone for sleep around 9 or 10 p.m. It is propping them up just as they should be feeling sleepy. Later on, in middle-age, the clock appears to shift back, making it hard for parents to stay awake just when their teens are at their most alert.

Carskadon discovered other important patterns in adolescent sleep. By studying alertness, she determined that teens, far from needing less sleep, actually needed as much or more sleep than they had gotten as children -- nine and a quarter hours. Most teenagers weren't getting nearly enough -- an hour and a half less sleep than they needed to be alert. And the drowsiness wasn't only in the early morning. Teens had a kind of sleep trough in the mid-afternoon and then perked up at night, even though they hadn't had a nap.

Carskadon is now exploring the effect of light in setting adolescent sleep patterns, for darkness seems to trigger the release of melatonin, often called the "sleep" hormone. Measuring melatonin also helps researchers define the different circadian rhythms of children, teens, and adults.

Sleep Debt

A great concern of sleep researchers is that teens are so sleep-deprived. Bill Dement speaks about the huge sleep debt that many teens and adults carry around with them every day. With most high schools in the U.S. starting around 7:20 a.m. and with many teens going to bed between 11 and 12 p.m., sleep researchers worry that teenagers are suffering an epidemic that is largely hidden. Since students are often driving to school, to sporting events, and home from late-night parties, this sleep debt holds huge risks. Many high school students know of someone, often a high-achieving kid, who on

the drive back from a sporting event or dance simply fell asleep at the wheel. On a less dramatic note, there are literally millions of adolescents who feel despondent, get poor marks, or are too tired to join high-school teams all because they are getting too little sleep. Because of their deep concern about these issues, sleep researchers are pushing for later school start times and are trying to introduce sleep issues into the high school curriculum.

Sleep, Learning, and Memory

The other area of sleep research relevant to teenagers, their parents, and teachers is the effect of sleep on learning and memory. In experiments done at Harvard Medical School and Trent University in Canada, students go through a battery of tests and then sleep various lengths of time to determine how sleep affects learning. What these tests show is that the brain consolidates and practices what is learned during the day after the students (or adults, for that matter) go to sleep. Parents always intuitively knew that sleep helped learning, but few knew that learning actually continues to take place while a person is asleep. That means sleep *after* a lesson is learned is as important as getting a good night's rest before a test or exam.

This research is done by giving students a series of tests. The students are trained, for instance, to catch a ball attached by a string to a cone-like cup. As they repeat the skill during the test day, they are able to do it faster and more accurately. Let's say they go from catching a ball 50 percent to 70 percent of the time over a period of half an hour. The students who get a good night's sleep improve when they are retested. On a retest three days after they have a good night's sleep, they might catch a ball 85 percent of the time. The other students who got less than six hours sleep either do not improve or actually fall behind.

Some of the tests are more demanding. They are called cognitive procedural tasks and they mimic what a student might learn in physics or math, or in certain sports. They present the student with something new to be learned or require an ability to conceptualize, to form a picture of the task in their minds.

The brain consolidates learning during two particular phases of sleep. According to Dr. Robert Stickgold of Harvard University Medical School, who conducted a series of tests involving visual tasks, the brain seems to need lots of slow-wave sleep and a good chunk of another kind of sleep,

Rapid Eye Movement, or REM. Dr. Stickgold hypothesizes that the reason the brain needs these particular kinds of sleep is that certain brain chemicals plummet during the first part of the night, and information flows out of the hippocampus (the memory region) and into the cortex. He thinks the brain then distributes the new information into appropriate networks and categories. Inside the brain, proteins strengthen the connections between nerve cells consolidating the new skills learned the day before. Then later, during REM, the brain re-enacts the lessons from the previous day and solidifies the newly-made connections through the memory banks.

What these studies show is that learning a new task, whether it is sports or music, will be greatly helped by getting a good night's sleep and that students' ability to remember things, be it a lesson on geometry or the causes of the Second World War, is mediated by sleep.

The proposition that sleep aids the learning process is accepted by many researchers. In a review of the Harvard studies, the late Chris Gilpin described the research as "the most believable data ever collected that a specific memory function is associated with sleep." However, a recent study published in the November 2001 issue of the journal *Science* challenges that conclusion. After conducting a literature review, Jerome M. Siegel of the UCLA Department of Psychiatry and Brain Research and the Center for Sleep Research, judged the evidence of a link between REM sleep and learning to be "weak and contradictory." He pointed to inconsistent results from human and animal studies, and argued that studies of humans who do not experience REM sleep (due to brain injuries or pharmacological reasons) do not show memory problems. Siegel concludes, however, that although he does not believe that the existing literature points to a link between REM sleep and memory consolidation, "just as nutritional status, ambient temperature, level of stress, blood oxygenation, and other variables clearly affect the ability to learn, adequate sleep is vital for optimal performance in learning tasks."

Learning Good Sleep Habits

Putting good sleep habits into practice is particularly difficult for teenagers. Not only do their own circadian rhythms fight against going to sleep early, but many teens don't have any control over the time they wake up. Teens can do something to try to bring their internal body clock forward. Sleep experts say dimming the lights at night and getting lots of daylight in the morning

can help. Having a routine bedtime of 10 p.m., sleeping in a cool environment and turning off music, the Internet, and televisions would help to reset the body clock. And though sleeping in is a good thing, trying to get up after only an extra hour or two is a lot better than "binge-sleeping" on the weekends. If a student is used to getting up at 6:30 a.m., they shouldn't sleep until noon on the weekend. That simply confuses their bodies. And lots of sports helps, too -- better earlier in the day than late.

Sleep research not only points out the importance of sleep to teenagers, but explodes some of the myths around sleep: principally the idea that people need less and less sleep as they grow up. There are many factors in the lives of adolescents that elude their control. Sleep is one area where the lessons are clear and the benefits of following them are quickly apparent.

[1]Mary Carskadon, "When Worlds Collide: Adolescent Need for Sleep Versus Societal Demands", in *Adolescent Sleep Needs and School Starting Times*, editor Kyla Wahlstrom, Phi Delta Kappa Educational Foundation, 1999

[2] William C. Dement, *The Promise of Sleep*, Dell Paperback 1999, p. 85