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Snooze or Lose

Overstimulated, overscheduled kids are getting at least an hour's less sleep than they need, a deficiency that, new research reveals, has the power to set their cognitive abilities back years.

By Po Bronson Published Oct 7, 2007

(Photo: Martine Fougeron)

Morgan is a 10-year-old fifth-grader in Roxbury, New Jersey. She's fair-skinned, petite, with freckles across her nose and wavy, light-brown hair. Her father is a police sergeant on duty until 3 a.m. Her mother, Heather, works part time, devoting herself to shuffling Morgan and her brother to their many activities. Morgan plays soccer, but her first love is competitive swimming, with year-round workouts that have broadened her shoulders. She's also a violinist in the school orchestra, with practices and lessons each week. Every night, Morgan sits down to homework before watching *Flip This House* or another show with her mother. Morgan has always appeared to be an enthusiastic, well-balanced child.

But once Morgan spent a year in the classroom of a demanding teacher, she could no longer unwind at night. Despite a reasonable bedtime of 9:30 p.m., she would lay awake in frustration until 11:30, sometimes midnight, clutching her leopard-fur pillow. On her fairy-dust purple bedroom walls were taped index cards, each with a vocabulary word Morgan was having trouble with. Unable to sleep, she turned back to her studies, determined not to let her grades suffer. Instead, she saw herself fall apart emotionally. During the day, she was noticeably crabby and prone to crying easily. Occasionally, Morgan nearly fell asleep in class.

Concerned about her daughter's well-being, Heather asked the family's pediatrician about Morgan's sleep. "He kind of blew me off and didn't seem interested in it," she recalls. "He said, 'So she gets tired once in a while. She'll outgrow it.'"

The pediatrician's opinion is typical. According to surveys by the National Sleep Foundation, 90 percent of American parents think their child is getting enough sleep. The kids themselves say otherwise. In those same surveys, 60 percent of high schoolers report extreme daytime sleepiness. In another study, a quarter admit their grades have dropped because of it. Over 25 percent fall asleep in class at least once a week.

The raw numbers more than back them up. Half of all adolescents get less than seven hours of sleep on weeknights. By the time they are seniors in high school, according to studies by the University of Kentucky, they average only slightly more

than 6.5 hours of sleep a night. Only 5 percent of high-school seniors average eight hours. Sure, we remember being tired when we went to school. But not like today's kids.

It has been documented in a handful of major studies that children, from elementary school through high school, get about an hour less sleep each night than they did 30 years ago. While parents obsess over babies' sleep, this concern falls off the priority list after preschool. Even kindergartners get 30 minutes less a night than they used to.

There are many causes for this lost hour of sleep. Overscheduling of activities, burdensome homework, lax bedtimes, televisions and cell phones in the bedroom all contribute. So does guilt; home from work after dark, parents want time with their children and are reluctant to play the hard-ass who orders them to bed. All these reasons converge on one simple twist of convenient ignorance: Until now, we could overlook the lost hour because we never really knew its true cost to children.

Using newly developed technological and statistical tools, sleep scientists have recently been able to isolate and measure the impact of this single lost hour. Because children's brains are a work-in-progress until the age of 21, and because much of that work is done while a child is asleep, this lost hour appears to have an exponential impact on children that it simply doesn't have on adults.

The surprise is how *much* sleep affects academic performance and emotional stability, as well as phenomena that we assumed to be entirely unrelated, such as the international obesity epidemic and the rise of Attention Deficit Hyperactivity Disorder. A few scientists theorize that sleep problems during formative years can cause permanent changes in a child's brain structure: damage that one can't sleep off like a hangover. It's even possible that many of the hallmark characteristics of being a tweener and teen—moodiness, depression, and even binge eating—are actually symptoms of chronic sleep deprivation.


(Photo: Martine Fougeron)

Dr. Avi Sadeh of Tel Aviv University is one of the authorities in the field. A couple of years ago, Sadeh sent 77 fourth-graders and sixth-graders home with randomly drawn instructions to either go to bed earlier or stay up later for three nights. Each child was given an actigraph (a wristwatchlike device that's equivalent to a seismograph for sleep activity), which enabled Sadeh's team to learn that the first group managed to get 30 minutes more sleep per night. The latter got 31 minutes less sleep.

After the third night's sleep, a researcher went to the school in the morning to test the children's neurobiological functioning. The test they used is highly predictive of

both achievement-test scores and how teachers will rate a child's ability to maintain attention in class.

Sadeh knew that his experiment was a big risk. "The last situation I wanted to be in was reporting to my grantors, 'Well, I deprived the subjects of only an hour, and there was no measurable effect at all, sorry—but can I have some more money for my other experiments?'" he says.

Sadeh needn't have worried. The effect was indeed measurable—and sizable. The performance gap caused by an hour's difference in sleep was bigger than the normal gap between a fourth-grader and a sixth-grader. Which is another way of saying that a slightly sleepy sixth-grader will perform in class like a mere fourth-grader. "A loss of one hour of sleep is equivalent to [the loss of] two years of cognitive maturation and development," Sadeh explains.

Sadeh's findings are consistent with other researchers' work, all of which points to the large academic consequences of small sleep differences. Dr. Monique LeBourgeois of Brown University studies how sleep affects pre-kindergartners. Virtually all young children are allowed to stay up late on Fridays and Saturdays. Yet she's discovered that the sleep-shift factor alone is correlated with performance on a standardized school-readiness test. Every hour of weekend shift costs students seven points on the test. Dr. Paul Suratt of the University of Virginia studied the impact of sleep problems on vocabulary-test scores of elementary-school students. He also found a seven-point reduction in scores. Seven points, Suratt notes, is significant: "Sleep disorders can impair children's I.Q.'s as much as lead exposure."

Every study done shows a similar connection between sleep and school grades—from a study of second- and third-graders in Chappaqua to a study of eighth-graders in Chicago. The correlations really spike in high school, because that's when there's a steep drop-off in kids' sleep. Dr. Kyla Wahlstrom of the University of Minnesota surveyed more than 7,000 high schoolers in Minnesota about their sleep habits and grades. Teens who received A's averaged about fifteen more minutes sleep than the B students, who in turn averaged eleven more minutes than the C's, and the C's had ten more minutes than the D's. Wahlstrom's data was an almost perfect replication of results from an earlier study of more than 3,000 Rhode Island high schoolers by Brown's Mary Carskadon. Certainly, these are averages, but the consistency of the two studies stands out. Every fifteen minutes counts.

With the benefit of functional MRI scans, researchers are now starting to understand exactly how sleep loss impairs a child's brain. Tired children can't remember what they just learned, for instance, because neurons lose their plasticity, becoming incapable of forming the synaptic connections necessary to encode a memory.

A different mechanism causes children to be inattentive in class. Sleep loss debilitates our body's ability to extract glucose from the bloodstream. Without this stream of basic energy, one part of the brain suffers more than the rest: the

prefrontal cortex, which is responsible for what's called "executive function." Among these executive functions are the orchestration of thoughts to fulfill a goal, the prediction of outcomes, and perceiving consequences of actions. So tired people have difficulty with impulse control, and their abstract goals like studying take a back seat to more entertaining diversions. A tired brain perseverates—it gets stuck on a wrong answer and can't come up with a more creative solution, repeatedly returning to the same answer it already knows is erroneous.

Convinced by the mountain of studies, a handful of school districts around the nation are starting school later in the morning. The best known of these is in Edina, Minnesota, an affluent suburb of Minneapolis, where the high school start time was changed from 7:25 a.m. to 8:30. The results were startling. In the year preceding the time change, math and verbal SAT scores for the top 10 percent of Edina's students averaged 1288. A year later, the top 10 percent averaged 1500, an increase that couldn't be attributed to any other variable. "Truly flabbergasting," said Brian O'Reilly, the College Board's executive director for SAT Program Relations, on hearing the results.

Another trailblazing school district is Lexington, Kentucky's, which also moved its start time an hour later. After the time change, teenage car accidents in Lexington were down 16 percent. The rest of the state showed a 9 percent rise.


(Photo: Martine Fougeron)

Although the evidence is telling, few districts have followed this lead. Conversely, 85 percent of America's public high schools start before 8:15 a.m. Thirty-five percent start at or before 7:30 a.m. In New York City, each school principal sets his own school schedule, and a randomized sample of 50 of the city's 500 public high schools revealed that 30 percent begin by or before 7:30. At Midwood, class starts at seven on the dot; Van Buren lets you slide in at 7:05.

Obstacles to later start times are numerous. Having high schools start earlier often allows buses to first deliver the older students, then do a second run with the younger children. This could mean doubling the size of the bus fleet. Teachers prefer driving to school before other commuters clog the roads. Coaches worry their student athletes will miss games because they're still in class at kickoff time.

Dr. Mark Mahowald, a University of Minnesota professor who runs a sleep clinic, has been at the center of many school start-time debates, and he dismisses those claims. "Of all the arguments I've heard over school start-times, not one person has argued that children learn more at 7:15 a.m. than at 8:30."

Parents and educators might remain skeptical about the importance of the lost hour, but the sleep-research community considers the evidence irrefutable. Their

convictions hardened as scientists began to understand sleep's vital role in synthesizing and storing memories.

Dr. Matthew Walker of UC Berkeley explains that during sleep, the brain shifts what it learned that day to more efficient storage regions of the brain. Each stage of sleep plays a unique role in capturing memories. For example, studying a foreign language requires learning vocabulary, auditory memory of new sounds, and motor skills to correctly enunciate new words. The vocabulary is synthesized by the hippocampus early in the night during "slow-wave sleep," a deep slumber without dreams. The motor skills of enunciation are processed during Stage 2 non-rem sleep, and the auditory memories are encoded across all stages. Memories that are emotionally laden get processed during R.E.M. sleep. The more you learned during the day, the more you need to sleep that night.

To consolidate these memories, certain genes appear to up-regulate during sleep; they literally turn on, or get activated. One of these genes is essential for synaptic plasticity, the strengthening of neural connections. The brain does synthesize some memories during the day, but they're enhanced and concretized during the night: New inferences and associations are drawn, leading to insights the next day.

Perhaps most fascinating, the emotional context of a memory affects where it gets processed. Negative stimuli get processed by the amygdala; positive or neutral memories get processed by the hippocampus. Sleep deprivation hits the hippocampus harder than the amygdala. The result is that sleep-deprived people fail to recall pleasant memories yet recall gloomy memories just fine.

In one experiment by Walker, sleep-deprived college students tried to memorize a list of words. They could remember 81 percent of the words with a negative connotation, like *cancer*. But they could remember only 41 percent of the words with a positive or neutral connotation, like *sunshine* or *basket*.

"We have an incendiary situation today," Walker remarks, "where the intensity of learning that kids are going through is so much greater, yet the amount of sleep they get to process that learning is so much less. If these linear trends continue, the rubber band will soon snap."

While the neurocognitive sleep discoveries are impressive, there's equally groundbreaking research on how sleep affects metabolism.

Five years ago, already aware of an association between sleep apnea and diabetes, Dr. Eve Van Cauter at the University of Chicago discovered a "neuroendocrine cascade" that links sleep to obesity.

Sleep loss increases the hormone ghrelin, which signals hunger, and decreases its metabolic opposite, leptin, which suppresses appetite. Sleep loss also elevates the stress hormone cortisol. Cortisol is lipogenic, meaning it stimulates your body to make fat. Human growth hormone is also disrupted. Normally secreted as a big pulse at the beginning of sleep, growth hormone is essential for the breakdown of

fat.

It's drilled into us that we need to be more active to lose weight. So it spins the mind to hear that a key to staying thin is to spend more time doing the most sedentary inactivity humanly possible. Yet this is exactly what some scientists seem to be finding. In light of Van Cauter's discoveries, sleep scientists have performed a flurry of analyses on children. All the studies point in the same direction: On average, children who sleep less are fatter than children who sleep more. This isn't just in the U.S.; scholars around the world are considering it, as they watch sleep data fall and obesity rates rise in their own countries.

Three foreign studies showed strikingly similar results. One analyzed Japanese elementary students, one Canadian kindergarten boys, and one young boys in Australia. They all showed that kids who get less than eight hours of sleep have about a 300 percent higher rate of obesity than those who get a full ten hours of sleep. Within that two-hour window, it was a "dose-response" relationship, according to the Japanese scholars.

In Houston public schools, according to a University of Texas at Houston study, adolescents' odds of obesity went up 80 percent for each hour of lost sleep.

Sleep's role in obesity is a comparatively new theory, and one difficult to prove in a controlled experiment. But the traditional approach to solving childhood obesity is an abject failure. The federal government spends over a billion dollars a year on nutrition-education programs in our schools. A recent analysis by McMaster University in Hamilton, Ontario, found that of 57 such programs, 53 had no effect whatsoever, and the four remaining programs' results were meager at best.

For a long time, there's been one culprit to blame for these failed efforts: television. Rather than running around the neighborhood like when we were young, today's kids sit in front of the boob tube an average of 3.3 hours a day. The connection to obesity seemed so obvious that few people thought it needed to be supported scientifically.

Last year, Dr. Elizabeth Vandewater at the University of Texas at Austin got fed up with hearing scholars blame it all on television. "It's treated as gospel without any evidence," she says. "It's just bad science." Vandewater analyzed the best large data set available, the Panel Study of Income Dynamics, which has extensively surveyed 8,000 families since 1968. She found that obese kids watch no more television than kids who aren't obese. All the thin kids watch massive amounts of television, too. There was no statistical correlation between obesity and media use, period. "It's just not the smoking gun we assumed it to be."

Vandewater examined the children's time diaries, and she realized why the earlier research had got it wrong. "Children trade functionally equivalent things. If the television's off, they don't go play soccer," she says. "They do some other sedentary behavior."

In fact, while obesity has spiked exponentially since the seventies, kids watch only

seven minutes more TV a day. Although they do average a half-hour of video games and Internet surfing on top of television viewing, the leap in obesity began in 1980, well before home video games and the invention of the Web browser. This doesn't mean it's healthy to watch television. But it does mean that something other than television is making kids heavier.

"We've just done diet and exercise studies for a hundred years and they don't work well, and it's time to look for different causes," says Dr. Richard Atkinson, co-editor-in-chief of the *International Journal of Obesity*.

Despite how persuasive all this science is, somehow it still seems like a huge leap of faith to consider giving back an hour of our children's lives to slumber. Statistical correlations are fine evidence for scientists, but as parents, we want more—we want control.

Dr. Judith Owens runs a sleep clinic in Providence, Rhode Island, affiliated with Brown. Recently, a father came in with his 15-year-old daughter, who was complaining of severe headaches. Interviewing the patient, Owens quickly learned that her daily routine was a brutal grind; after violin lessons, bassoon lessons, dance classes, and the homework from honors classes, she was able to get only five hours of sleep a night before waking every morning at 4:30 to hustle off to the gym. The father wanted to know if a lack of sleep could be causing her headaches. Owens told him that was probably the case. She recommended his daughter cut back on her schedule.

The word *probably* made this father hesitant. He would let her cut back, but only if Owens could prove, in advance, that sacrificing an activity would stop the headaches. Sure, he knew that sleep was important, but was it more important than honors French? Was it more important than getting into a great college?

Owens tried her standard argument. "Would you let your daughter ride in a car without a seat belt? You have to think of sleep the same way." But in the father's mind, he saw the transaction the other way around: Cutting back was putting his daughter at risk. What if the headaches didn't stop and she gave up one of her great passions, like dance, for no reason?

Long before children become overscheduled high schoolers gunning for college, parents start making trade-offs between their kids' sleep and their other needs. This is especially true in the last hour of a child's day, a time zone let's call "the Slush Hour." The Slush Hour is both a rush to sleep and a slush fund of potential time, sort of a petty-cash drawer from which we withdraw ten-minute increments. During the Slush Hour, children should be in bed, but there are so many competing priorities. As a result, sleep is treated much like the national debt—*What's another half-hour on the bill?* We're surviving; kids can, too.

Sleep is a biological imperative for every species on Earth. But humans alone try to resist its pull. Instead, we see sleep not as a physical need but a statement of

character. It's considered a sign of weakness to admit fatigue, and it's a sign of strength to refuse to succumb to slumber. Sleep is for wusses.

But perhaps we are blind to the toll it is taking on us. The University of Pennsylvania's David Dinges did an experiment shortening adults' sleep to six hours a night. After two weeks, they reported they were doing okay. Yet on a battery of tests, they proved to be just as impaired as someone who has stayed awake for 24 hours straight.

Dinges did the experiment to demonstrate how sleep loss is cumulative, and how easily our judgment can be fooled by sleep deprivation. Nevertheless, it's easy to read his research and think, "I would suffer, but not that bad. I would be the exception." We've coped on too-little sleep for years and managed to get by. But when it comes to a child's developing brain, is just getting by enough?