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Exercise, Sleep, and ADHD

New Insights on Brain Growth

Science has now absorbed the reality that the brain is malleable and "plastic." That means the brain can to a surprising extent "reinvent itself" with learning, experience, or the right stimulation. We also now know that epigenetic changes in the brain help it do that. The limits on this ability and its sensitivity remain open frontiers for investigation. As a result, we're experiencing an explosion of scientific interest in whether we can build up attention and executive function, even self-regulation and behavioral control, by stimulating changes in gene expression in the brain. How far can we go with changes in lifestyle that also might stimulate epigenetic change? It turns out that, besides nutrition and diet, two major lifestyle activities that also affect general health are particularly relevant to growing exactly the parts of the brain that strengthen self-regulation, and thus can help counteract or improve ADHD. They are **exercise** and **sleep.** Getting exercise and getting enough sleep are obviously good for general health and good for all children. But for kids with ADHD, they may have specific benefits that are well worth your time.

Exercise

The benefits of exercise and overall fitness are well established for general health, mood, and stress management. These perks are increasingly popularized in the media. For example, *Time*'s cover story in September

2016 was on exercise as a medicine—highlighting the view of some specialists that exercise can be more effective than most drugs for many health conditions. But what is the real benefit for children, in particular for those with ADHD? How important is this particular lifestyle option? With the advent of studies that combine exercise and brain imaging, we are learning exactly what exercise can do for brain growth. And recent clinical trials have just started to determine to what extent exercise can help children with ADHD. While these are early days, the future is likely to bring further positive evidence.

Particularly interesting for ADHD in recent years is a series of findings showing that for developing children aerobic exercise expands the growth of brain connections, the frontal cortex, and the brain chemicals (such as serotonin and dopamine) that support self-regulation and executive functioning. These surprisingly specific findings in typically developing children have led to real excitement about the possibility that the right kind of exercise can help ADHD. We'll dig into this evidence, evaluate it, and sort out what kind of exercise is best based on the findings of just the last five years.

EXERCISE VERSUS SPORTS VERSUS "FREE PLAY"

But first a couple of preliminary considerations. We need to sort out exercise from its overlap with "free play" and "sports." Free play is essential; exercise is beneficial; sports are optional. Free play has its own inherent benefits independent of any exercise. Recent findings confirm that it helps children develop problem solving, coping skills, imagination, and self-directed learning. For preschool children, most free play involves large-motor activity and so is ideal for their development. However, for school-age children, free play is often less active. It remains just as important for other reasons. We don't know, however, if free play has any special importance for children with ADHD.

Sports, likewise, have a different set of benefits. They may provide exercise, although this varies with the sport. They can also promote self-discipline and provide camaraderie and social experience, and for children with ADHD who are good at the sport, a source of protective self-esteem. For some children with ADHD, athleticism is a compensating strength and an arena where they can gain some positive self-image to

offset their struggles in school. For others with ADHD who are not so gifted or inclined, sports can be an extremely frustrating and unhappy experience.

Vigorous exercise is critical to the developing brain—especially when ADHD is hindering that development—but don't assume that team sports are the only (or the best) choice for your child.

Either way, sports that involve a lot of waiting may not do enough for the brain or for fitness. Some sports are great for fitness: one-on-one racquetball, basketball, soccer, high-activity dancing, bicycling, running—in these sports there's plenty of vigorous exercise. In contrast, just playing nine-on-nine baseball, golfing with a cart, or eleven-on-eleven American football might not bring enough fitness, unless accompanied by a practice regimen that enforces fitness.

Keep in mind that children's fitness habits can stay with them into adulthood. If you played soccer throughout your childhood and adolescence, you might very well seek out an adult soccer league to play in. But for most adults, team sports are logistically challenging. That's why most adults in our society stay fit through individual exercise. Exercise is a good habit to instill early in life, not just because cardio and strength/flexibility training will be key to adult health, but because in childhood *cognitive and motor development work in tandem.* In the brain, extensive connections wire motor centers, like the cerebellum and the motor cortex, to areas involved in attention and executive functioning, like the prefrontal cortex and the basal ganglia. Some physiologists believe that for the best cognitive and self-regulation outcomes for kids, exercise should include complex motor learning and coordination—that is, general motor skill growth along with aerobic challenge. For preschoolers, this may naturally occur in their running, climbing, and wrestling around during free play. But for older children, it may require an organized activity, either individually or with a partner or a team. These might include activities like rock climbing, dance, basketball, or martial arts. Here again, you'll have to use some judgment to balance free play and structured activity. If your teenager is choosing her own activity for Saturday afternoon and decides to go rock climbing with a qualified supervisor, her free play and ideal exercise may be one and the same. On the other hand, if your ten-year-old chooses to use his free play time to build a model with Legos, or to

read, draw, or play with low-key games with friends outside, then he may need in addition to go for a vigorous bike ride or play a sport.

Before we focus on ADHD-related exercise benefits, therefore, put them in the context of these guidelines:

✓ **AT A GLANCE**

Action Steps for Choosing the Best Exercise

1. Group sports should be considered *optional,* and decisions made about enrolling your child in a specific sports program should be based on:
   - The level of vigorous exercise (breathing harder, heart rate up)
   - Your child's ability to enjoy the sport. If your child is thriving in a particular sport, encourage it. If he hates it, let him do something else.
2. Always allow your child with ADHD enough free play (active or not), adding exercise on top of free play if necessary.
3. The main thing is to get the exercise, which can be done in a lot of different ways. Stay open.

EXERCISE, EPIGENETICS, AND THE BRAIN

Exercise is one of the lifestyle factors with the clearest epigenetic effects. A sustained fitness program, at any age, causes *significant epigenetic changes* throughout the *body* (some of which are obvious, like heart and muscle genes) but, it turns out, also *in the brain*. The brain growth effects, under study for the past several years, now have a sufficiently large literature to be considered definite. They were confirmed in comprehensive scientific reviews in 2013 and 2014.

The *epigenetic* effects on the brain are still being studied, but evidence so far is quite positive here as well. Animal studies suggest that exercise triggers epigenetic changes such as histone modifications or DNA methylation that specifically alter activity in genes that influence new neuron growth and extend neural dendritic connections. In plain English, this means that *exercise can exert effects that make the brain grow more and get more efficient.* Even more encouraging regarding ADHD is

that this seems to happen in particular brain areas like the hippocampus, basal ganglia, and frontal cortex, which are fundamental to self-regulation and executive functioning. In these animal studies mice either exercise vigorously or not, and then are examined for brain growth, gene expression, and epigenetic changes. Do such animal studies prove that children who exercise will get the same benefits? It's a bit of a stretch, but actually it doesn't get much better than this as far as effects we would want to see in an animal model go. So these studies, while preliminary, are extremely encouraging. Let's look at the effects of exercise on children in three areas most relevant to ADHD: learning, attention, and ADHD symptoms.

Exercise positively affects precisely the areas of the brain that control the functions at the heart of ADHD: self-regulation and executive skills.

Exercise and Academics/Learning

One of the biggest reasons that inattention is a problem is it interferes with academics. In fact, my colleagues and I, and many others, have shown that attentional control, self-regulation, and executive function are the most important predictors of academic success—more important than IQ or behavioral problems. For kids with ADHD, academic problems are the number one complaint along with behavioral problems. Therefore, one of the most important areas for us to look at with exercise is whether it helps kids with their academics, and in particular with the executive function part of academic success.

Fortunately, developmental studies of child exercise have used academic results as a primary focus (in part because school PE programs make it a natural place to do safe, controlled experiments). Despite this, the caveat is that this literature is still short on very-high-quality randomized trials of the sort that provide the acid test of exercise benefits. However, a major monograph published in 2014 by the Society for Research in Child Development concluded that overall, exercise led to improved academic performance in children—*more than equivalent additional class or study time.* In other words, school poli-

Cutting phys ed classes in favor of academics is enormously self-defeating for child learning.

cies to cut physical education classes are a mistake. The science indicates that schools should convert physical education classes into physical fitness classes and keep them going.

Exercise and Attention/Executive Functions

Testifying to the explosion of interest in this area, the years 2013, 2014, 2015, and 2016 each saw updated scientific reviews in which experts assembled all available studies to see if exercise actually improved the mental abilities necessary for self-regulation that are typically impaired in ADHD. One in the *Annual Review of Psychology* (2014) concluded that typically developing children show better attention and executive function on the day they exercise—suggesting exercise prior to going to school could be useful. Altogether these authoritative reviews lead to the following conclusions:

- Fitness is associated with better child working memory, response inhibition, and learning.
- This holds up clearly in large correlational studies but is also supported in the more informative prospective and randomized controlled studies.

We definitely need more randomized trials to gain confidence here, but if we try to peer into the future, the most likely picture is that exercise improves attention and even executive functioning in typically developing children and therefore directly counteracts ADHD by building self-regulation in the brain. Until the 2010s, we had no direct data, however, on whether ADHD itself would improve with exercise. Now such data is finally emerging, albeit slowly.

Exercise and ADHD

Over two dozen studies now have evaluated whether children with ADHD benefit from an exercise program. Unfortunately, these studies are all very small and riddled with inconsistency and methodological limitations, so this is not yet a "mature" literature that allows confident

conclusions. But they let us begin, in Gretzky's words, to "skate to where the puck is going," and see what the most likely future picture will be. Between 2014 and 2016, three scientific reviews attempted to quantify the actual benefits of exercise programs across all studies as a treatment for ADHD, and a fourth summarized a larger number of studies that could not be pooled due to their differences in approach. A 2015 meta-analysis (statistical summary of all studies) found seven small studies of aerobic fitness in ADHD. These were all flawed in some way (for example, none were able to clearly disguise from the participants what condition they were in, leading to possible expectation effects or compliance effects) and small (fewer than fifty kids, increasing the risk of a chance finding or of finding exaggerated effects). In other words, they may overestimate effects. In particular, lack of clear blinding of observers is a problem because it means that observers' own beliefs and expectations will influence the results. All were short term (three studies ran for one week, three ran for five to six weeks, and one ran for ten weeks)—effects might take longer to take hold. However, with these cautions in mind, the pooled data were still encouraging: benefits on hyperactivity, attention, executive function, and cognition equaled about half the effect of medication—and were greater than the effect of diet—for the children with ADHD. In other words, these effects were big enough that you would notice them in everyday life. Based on the history of diet research, what's likely is that subsequent larger studies will confirm these effects are real, while ultimately finding that the size of the effect is a bit less than claimed in the 2015 paper. The much larger review of studies in 2016, while it did not pool the results, drew the conclusion that aerobic exercise yielded a believable benefit for children with ADHD—both in their symptoms and in their overall health. Strength-building exercise (such as yoga, tai chi, weights, CrossFit, or others) is not sufficiently well studied yet to draw conclusions about it.

Current research, while still preliminary, does suggest that aerobic exercise can provide noticeable improvements in ADHD symptoms—about half as much as medication but possibly more than dietary changes. Larger studies in the future will likely confirm the effects but show that they're not quite as strong as we've seen so far.

Caveats: What We Still Don't Know

Which kinds of exercises don't help the brain? Most research has been on cardio (aerobic) exercise. What about strength training or other types of exercise? Work on this is just beginning. How permanent are benefits in children? Most studies are on adults, and most experimental trials with children have been pretty limited. What is the benefit of sustained fitness programs (as opposed to same-day or same-week benefit) for kids with ADHD? This has not yet been studied. How big are individual differences? Should different kids with different genetic makeups have different kinds of exercise to maximize their brain growth and attention? This new area is important. Like everything else in this book, it won't end up being one size fits all. A particular question is whether boys and girls benefit from the same activities; most studies to date have been on boys.

As with muscles, the effects of exercise on the brain depend on keeping at it over time.

How long should you continue the fitness program to help treat ADHD? It's unknown. Even a week can help—but only temporarily. Even though exercise causes epigenetic changes, it takes sustained exercise over time for those to build up to a noticeable influence on growth. Truly growing the brain is like growing the muscles—it requires sustained fitness, suggesting you should maintain the effort over several weeks or months.

TAKE-HOME POINTS

Exercise and ADHD

If your child has ADHD, the benefits of exercise are even more important than for other kids. The unique effects of exercise on the brain networks and gene expression patterns that support maturation of self-regulation should make you sit up and take notice.

- Exercise and fitness have a nice side effect of protecting your child from serious health problems (like obesity and diabetes), improving health in such areas as skin, muscle, and bone, and improving

coordination, while advancing your goal of brain growth in systems that support self-regulation and help combat ADHD.

- With epigenetic effects involved, developmental effects may well be sustained even during years that exercise slacks off—we are still learning how many effects are short term versus long term in this regard.
- A final benefit shown in studies is that exercise is a powerful route to creating epigenetic change that can overcome negative events earlier in life. For example, animal studies have reported that exercise can prevent or reverse the epigenetic effects of stress and trauma in early life—the topic of our next chapter.
- A good diet provides more energy for exercise as well.
- Exercise can be fun—it's sometimes a matter of finding the right outlet to pique your child's interests. For some families, it helps to exercise with your child—a shared bike ride, hike, run, or game.

✓ **AT A GLANCE**

Exercise and ADHD Action Steps

On several occasions in the past decade, scientists have surveyed the landscape for typically developing children. Lacking ADHD-specific guidelines, our best bet is to go with these general guidelines but to highlight their likely extra relevance to children with ADHD, who need every boost they can get in relation to learning, attention, executive function, and self-regulation. Here are the general and most common recommendations.

Make sure your child gets at least one hour a day of moderate and moderate-to-intensive exercise (heart rate up and breathing a bit harder). It doesn't have to be all at once. It can be one sixty-minute period, two thirty-minute periods, or four fifteen-minute periods. (These guidelines come from the American Heart Association.) Some children need more exercise than others. Some children may be happier and calmer if they can get two hours a day, but even some exercise will help their health and mood.

If realistically feasible, try for the main exercise at the beginning of the day so your child is ready for the school day. While difficult to arrange, some schools and some families have been able to do this. It's the ideal! However, obviously that won't be possible for everyone. Most kids will have to go to school and then get their exercise after school, in addition to what we all hope is recess time.

Make sure the exercise includes a mix of moderate activity (walking, level bicycling, roller blading, skateboarding, jumping rope, playing on the playground) and moderate to intense activity sufficient to make the child huff and puff or break a sweat (running, cycling on hills, swimming, vigorous dancing, martial arts, soccer, basketball, playing chase, gymnastics, sustained calisthenics). (These recommendations come from the British National Health Service.) The activity should be consistent during the time period—don't count activities that include a lot of standing around or waiting for a turn.

Include activities that involve motor skill learning and coordination—that is, some cognitive challenge. While the extra benefits of this approach are not yet definitive, it is possible that added brain growth happens here. Most ball sports involve at least some motor learning, while dance, martial arts, rock climbing, gymnastics, CrossFit, or some calisthenics like jump rope may entail more complete whole-body muscle learning.

It's okay to mix activities; you don't have to hit all aspects every day. For example, your child may like to run sometimes and play soccer or basketball other times, or to dance a couple times a week and go bike riding other times.

Include free play if exercise is all structured. School-age kids should get an hour of free play and an hour of good exercise—that's two hours unless the free play is moderate to vigorous exercise.

Don't be too hard on yourself if you can't hit the ideals—some exercise for your child is better than none. A few ideas from parents who have been there can be found in the box on the facing page.

IDEAS FOR MEETING THE EXERCISE CHALLENGE

For many families, fitting in exercise is a real challenge, depending on climate, weather, cost, and neighborhood. It may prove necessary to have different activities in summer and winter. While organized school or community sports after school work for many families, they aren't for all. Here are some examples of other solutions families found:

- Alison went for a long bike ride with her son before school on nice days.
- Alejandro enrolled his daughter in a special martial arts class for children with ADHD.
- Mike installed a heavy punching bag in the basement and taught his teen son how to do workouts with it.
- Jill was able to get her two children outside to jump rope, play hopscotch, play tag, and engage in other active play with some neighbor friends several times a week, enough to see some change in their mood.
- Tania was able to get her daughter into dance lessons that she enjoyed.
- Bob loved running and got his preteen kids interested in going running with him, setting up fun competitions. This resulted in the kids joining running sports in high school as a major hobby.

Sleep and ADHD

Sleep and ADHD are definitely intertwined. Knowledge here has continued to expand rapidly. This is a major lifestyle consideration that goes along with exercise and diet. The science has a lot to tell us about sleep and brain development, as well as about ADHD. It turns out that many children have sleep problems of one sort or another, that sleep's importance is difficult to overestimate, and that many tools are available to boost your child's self-regulation and brain development with better sleep.

Chances are you don't get enough sleep and neither do your kids. National surveys indicate that 70 percent of teens and 70 percent of adults are not getting enough sleep.

First, if you are worried about your child's sleep, you are not alone.

Sleep problems are very common in children. In one recent national survey, over half of parents reported their child had some sort of sleep problem, and *one-fourth* of parents reported their child did not get enough sleep. Based on the prevalence of sleep issues, some of the co-occurrence of ADHD and sleep problems is just the random overlap of two common problems. But let's dig deeper. There are causal connections.

Kids use sleep to lock in that day's learning.

During sleep, the brain grows new connections, stores memories, and repairs cells. One striking scientific finding is called sleep-dependent memory consolidation, or *sleep-dependent learning*. This means it's during sleep that learning takes hold. You may be all too familiar with the common complaint in ADHD that a child seems to learn something one day but then has to learn it all over again the next day. This is an example of failure of memory consolidation. The fact is that children can't learn things if they don't sleep! Sleep is also crucial to managing stress and emotions and having the mental capacity for focused attention, as discussed in Chapter 1 and later when we focus on stress itself in Chapter 7.

Sleep seems to be nature's number-one tool for growing a child's brain.

As the brain is developing, it uses sleep in different distinct ways in early life. Infants use sleep to generalize from one experience to another. Their naps play a crucial role in learning. Recent experiments have shown that babies exposed to new learning remember it if they have napped in between the tests, but not if they stayed awake. Preschoolers use sleep to retain specific things they learned during the day. Children, teens, and adults continue to use sleep to lock in learning.

In recent years, studies like those just mentioned have clarified, in animals and humans, that children and adults learn just as much asleep as while awake. As with babies, when they see new information, they remember it better if they sleep before the memory test than if they don't. Brain-imaging studies using magnetic resonance imaging (MRI) detect patterns of brain activation that show something remarkable: a particular brain pattern activates when seeing new information awake, *and the same pattern is replayed during sleep.* This indicates that during sleep the brain works to consolidate and store what it learned in the daytime.

Now sleep scientists do not see sleep as merely helpful in child learn-

MYTH: NOTHING IMPORTANT HAPPENS DURING SLEEP

Sleep-dependent learning involves the hippocampus, a structure exquisitely organized for different stages of learning and then sending that information to storage. It connects to the frontal cortex to capture new learning and to find out what to retrieve for use in an immediate situation. These brain regions and connections talk to each other and build new wires extensively during childhood—*doing much of their work during sleep.* During sleep they become flexible and able to rewire, and especially in deep sleep, the brain rewires to store new learning. In just the last few years, scientists have been able to show that this process of learning and memory consolidation works in a different way at different stages of development—infancy, childhood, the teen years.

ing—they see it as *necessary*. In fact, some recent studies suggest that children who sleep more have higher IQs, as well as better attention and self-control—all very relevant if your child has ADHD!

SLEEP AND EPIGENETICS

By now you should not be surprised to find out that sleep regulation, like so many other functions, depends not just on genetics but on epigenetic signaling. For example, a study in 2015 looked at pairs of identical twins in which one twin wanted to go to sleep early in the evening and the other wanted to go to sleep later. The study found the twins had differences in epigenetic marks on certain circadian genes—implying changes in how those genes were functioning in the brain. This finding fell right in line with what our group found when we published the first study of the entire epigenome of children with ADHD in 2015. This was a pilot study, meaning it was designed to test out the procedure for a future study, and we are now following up with that much larger study. The preliminary study, meanwhile, identified a handful of genes that showed epigenetic alterations in ADHD in the children with ADHD versus typically developing young people. One of the most prominent was a gene called VIPR2, which is involved in circadian clock regulation. While not confirmed, that finding does raise interesting linkages.

Some sleep problems likely develop from early experiences that disrupt the settings of the brain's circadian clock via epigenetic change. We already know from a great deal of research that the day–night cycle sets off light-sensitive reactions in key areas of babies' brains that are part of their normal development, so babies adapt to the light–dark cycle where they live. Epigenetic changes do that coding in their young brain. If epigenetic changes early in a child's life can affect how the child sleeps, can we provide training or other experiences that will reverse a current sleep problem? We don't know for sure, but everything we've learned so far about epigenetics suggests that it's possible. Let's look at the best ideas for how to resolve a sleep problem.

SLEEP, ATTENTION, AND SELF-REGULATION

We don't need research studies to tell us that we can't focus, pay attention, or concentrate well without good sleep. But science adds an important detail: this problem with attention can carry over even after sleep is restored. You also know from experience that your self-control quickly stumbles after a sleepless night. You can't cope nearly as well with stress, handle your emotions, or focus when overtired. The same goes in spades for kids, of course. In short, if your child isn't getting enough sleep, her attention and behavior may look a lot like ADHD. And what if your child *has* ADHD? Here are the facts regarding sleep and ADHD to keep in mind:

- Sleep is active, not passive. It's an essential part of wiring the brain and learning. Kids with ADHD usually have either delays or losses of brain development, as well as problems learning, so this is fundamental for them to try to recover.
- Lack of sleep can cause symptoms that resemble ADHD because sleep is necessary to maintain the mental capacity needed for self-regulation. Before we diagnose or treat ADHD, we need to make sure sleep is adequate.
- Children with ADHD only *occasionally* have intrinsic sleep disorders (like obstructive sleep apnea or restless legs syndrome). This should be evaluated when management of sleep-related behaviors

proves ineffective and your child still shows signs of not being rested.

- Children with ADHD *often* have sleep-related behavior problems that interfere with getting adequate sleep. We'll talk about the difference in a minute.

If your child isn't getting enough sleep, or enough good-quality sleep, then you can expect inattention, disorganization, moodiness, tantrums, irritability, and health problems from more colds to vague complaints. What's worse, your child's brain growth will not be happening under its preferred conditions. If you are like most parents, chances are decent that your kids may not be getting adequate sleep, simply by the law of averages—a substantial percentage of children (and adults) do not get adequate sleep in the United States! Our lives are often just too overloaded. Once again, many children may be able to tolerate this state of affairs without obvious ill effects. But if your child has ADHD, you have less margin for error to "let this one go." Sleep is an area where it might make a lot of sense to take some action.

HOW MUCH SLEEP SHOULD YOUR CHILD BE GETTING?

How much sleep developing children need may surprise you. The National Sleep Foundation recommends that from zero to two years of age infants and toddlers get more than twelve hours of sleep a day. Many, of course, get some of this by napping. Preschoolers need ten to thirteen hours (for a median of eleven hours). School-age children typically should be getting ten hours of sleep a night (some guidelines suggest eleven hours). While there can certainly be individuals who go outside of these ranges, for most of you that means if your child has to get up at 7:00 for school, she should be asleep by 9:00 P.M., starting to get ready for bed by 8:30 P.M., and turning off screens and ending stimulating activities by 8:00. Teens need only a little less—nine to ten hours, depending on which guidelines one follows. With school starting at 8:00 or 8:30, early bedtimes are required.

This is very difficult for teenagers, whose biological clocks are set for a later cycle than adults by evolution. That change in their body clocks is

not an aberration but a normal developmental phase of adolescence. The box below gives some sample sleep schedules based on National Sleep Foundation guidelines (*http://sleepfoundation.org*).

Sleep and Teenagers

The teen years are a special challenge for parents today. Teens are busy—too busy to get the sleep they need, just like adults! They still need at least nine hours of sleep, and ten might be better. Yet only 30 percent of teens even get eight hours of sleep per night. The challenge is particularly serious because teens naturally have later circadian clocks—they don't want to go to bed as early as adults do. Evolution has designed us that way. Ideally, teens could stay up late and sleep late—as many do in the summer and on weekends. This is natural for their development. If your teen has ADHD, however, this creates a difficult situation, because children with ADHD especially can ill afford to lose sleep. A further challenge for everyone is that school schedules conflict with the natural sleep cycle and circadian rhythm for children, and even more for teens. Teens are shoehorned into an early-morning schedule. Our academic calendar

HOW MUCH SLEEP DOES MY CHILD NEED?

SAMPLE SCHEDULES

	Target range	Median	Bedtime	Asleep	Wake
Preschool (3–5)	10–13 hrs.	11.5 hrs.	7:00 P.M.	7:30 P.M.	7:00 A.M.
School age (6–13)	9–11 hrs.	10 hrs.	8:30 P.M.	9:00 P.M.	7:00 A.M.
Teen (14–17)	8–10 hrs.	9 hrs.	9:30 P.M.	10:00 P.M.	7:00 A.M.
Young adult (18+)	7–9 hrs.	8 hrs.	10:30 P.M.	11:00 P.M.	7:00 A.M.

makes it harder for teens to get enough sleep. In 2014 the American Academy of Pediatrics issued a policy statement recommending that middle and high school should not start before 8:30 A.M. Yet fewer than 20 percent of schools comply with this recommendation at present; the average start time nationwide is 8:00 A.M., and some start earlier. In 2015 the calls for change grew louder. An expert summary of the problem and recommendations were provided in November 2015 in *Perspectives in Psychological Science,* which recommends pushing back high school start times as late as possible. Some municipalities are actively moving in that direction, and some states have moved most of their schools to an 8:30 or later start.

In the meantime, it's normal for teens, unfortunately, to struggle to go to sleep at night and get up in the morning. For some teens this pattern does cross the line to a delayed sleep–wake phase disorder—but you need a doctor to determine if it has. According to the American Academy of Sleep Medicine, the hallmarks of a delayed sleep–wake phase disorder are (1) difficulty getting to sleep and waking up and (2) sleepiness during the day.

What's Causing the Problem?

If you know your child isn't getting enough sleep and is showing the negative effects of undersleeping, you obviously need to figure out why this is happening. For kids with ADHD, sleep problems fall into two classes:

- Secondary sleep problems, such as problems with bedtime. Here, the problem is usually that ADHD is causing sleep problems!
- Primary sleep problems, such as biological sleep–wake cycle problem or obstructive sleep apnea. Here the sleep problems may be causing ADHD-like symptoms and behavior such as poor concentration, low energy, and irritability. Of course, some children have both types of problems and have ADHD.

Researchers have three basic methods for studying sleep in children, listed in the box on the next page. You can pursue one of these with a professional, but if you think your child has a sleep problem, my recom-

HOW SLEEP PROBLEMS ARE ASSESSED BY A PROFESSIONAL

- A short questionnaire (one is called the Children's Sleep Habits Questionnaire) or a sleep diary.
- A small motion sensor the size of a watch that is worn on the wrist or ankle. It tracks nighttime or twenty-four-hour activity and provides a rough gauge as to when a child is asleep.
- Polysomnography—that is, an overnight sleep study in a lab where the child is attached to electrodes that monitor sleep quality (brain waves) and breathing and other measures directly. This is the "gold standard" but expensive, and only sometimes warranted.
- Additional methods of sleep tracking using sensors and smartphones are emerging but not yet very dependable for clinical purposes. Use these with caution with children due to concerns about effects of blue screens on sleep, which we'll talk about shortly.

mendation is to start simple and just look at bedtime routines and sleep hygiene and attack the problem behaviorally. If the following remedies for secondary sleep problems don't help, that's the time to go further with clinical evaluation and treatment.

Secondary Sleep Problems: Bedtime and Sleep Hygiene

Knowing your child's ideal sleep schedule is the easy part. Creating a calm, successful bedtime routine is a lot more challenging for most parents. If you have a child with ADHD, he may be particularly resistant to bedtime, and because he's tired he may escalate and get a tantrum going right when you are trying to bring the day to a quiet end—and you're tired too! You have stuff to do. It can be very frustrating.

Here are the most common *behavioral sleep problems* recognized by the American Academy of Sleep Medicine. Although these problems are not indicators of ADHD, they are more common in children with the condition. So especially if your child has ADHD, you may recognize some of these.

- Falling asleep is an extended process that requires special conditions.
- Sleep-onset associations are highly problematic or demanding—that is, the child doesn't like to go to sleep.
- Without her special conditions, the child takes a long time to go to sleep or has other sleep disruptions.
- Nighttime awakenings require caregiver intervention for the child to return to sleep.
- Limit-setting problems occur:
  - The child has difficulty initiating or maintaining sleep.
  - The child stalls or refuses to go to bed at an appropriate time.
  - The child refuses to return to bed following a nighttime awakening.

The first line of defense to either prevent or overcome these types of problems is to establish basic "sleep hygiene"—the behavioral routine that makes sleep easier, including the bedtime routine. Let's go over that first.

The core of a good sleep hygiene routine is to have time before bed to prepare the body for sleep. This means that for at least an hour before bedtime your child should avoid blue light (computer, TV, and device screens—next section), large meals, and exercise. That's the time boundary. There is also a space boundary: Keep the bed only for sleeping. (For adults it is advised to keep the whole bedroom only for sleep, but for most families this isn't possible for children, whose bedrooms often double as playrooms and study rooms. But try to keep the *bed* for sleep only.) And as you probably know, it really is a bad idea to keep a TV in the bedroom.

Bottom line: Blue screens are a threat to sleep quality and should be avoided for at least an hour before bed. This includes mobile phones.

Behavioral Approaches to Fixing Sleep Problems. The behavioral sleep problems listed above can occur in any child but seem to be practically epidemic in children with ADHD. They are often caused by the

FAQ: IS THE CELL PHONE OR IPAD CAUSING MY CHILD'S SLEEP PROBLEMS?

Kids with ADHD love their electronics—video games, cell phones, computers, tablets, and TV. One speculation about why they like these things so much is that the frequent changes in stimulation probably help keep dopamine active in the brain and help them maintain an alert state. Unfortunately, these devices are also distracting and can interfere with social development, as I review in Chapter 5. Here there's another concern—the "blue light" they emit interferes with sleep.

Several studies in 2014 and 2015 confirmed what many clinicians long suspected. Children and adults who use mobile phones, computers, or televisions before going to bed sleep more poorly. The body naturally begins to produce melatonin when daylight dims to prepare for sleep. We now know that the blue light of backlit electronic screens is just the right wavelength to suppress that melatonin production. Studies using hourly saliva samples in children and adults confirm dramatic suppression of melatonin when light from the screens is reaching the eyes. Other studies using randomized controlled designs confirm that electronic screen use in the hour before bed causes insomnia (harder to fall asleep), changes in sleep stages (such as REM sleep), and less alertness the next day.

For example, in 2015 researchers in Boston reported striking findings about using e-readers or iPads (or similar devices) compared to reading a print book during the last hour before bed. Those who used the electronic reader were less sleepy, took longer to fall asleep, had later circadian timing (including changes in melatonin and changes in REM sleep), and were less alert the next morning. Those were young adults. The same is now observed in children using a simple correlational design. In 2015, a different group (also in Boston) surveyed over 2,000 fourth- and seventh-graders. Children who slept near a small screen (including sleeping near their phone), played computer games in the evening, or had TV in their room had less sleep and felt less rested. If you're interested in reading the study reports, here are the references to look up:

Chang, A. M., Aeschbach, D., Duffy, J. F., & Czeisler, C. A. (2015). Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness. *Proceedings of the National Academy of Sciences, 112,* 1232–1237.

Falbe, J., Davison, K. K., Franckle, R. L., Ganter, C., Gortmaker, S. L., Smith, L., et al. (2015). Sleep duration, restfulness, and screens in the sleep environment. *Pediatrics, 135*(2)., e367–375.

child having negative mental associations with going to bed or going to sleep. So one key concept is to replace those associations over time with very positive ones—making bedtime a really rewarding experience for the child.

Most parents are familiar with various sleep training programs and a welter of different advice for getting their babies on a regular sleep schedule. Even for school-age kids, however, a "sleep training" program is a helpful concept, even if the application is a little different than with infants. If your child has ADHD, then this type of approach may be particularly helpful in overcoming a sleep/bedtime behavior problem.

A randomized controlled clinical trial in 2014 showed that a formal "sleep training program"—that is, a professionally guided behavior program with a counselor—led to noticeable improvements in mood, emotion, and overall adjustment for children with ADHD. In comparison, simply giving parents information about sleep hygiene did not fare as well. The reason is probably obvious to you—implementing a new sleep schedule is not easy, and you may need a consistent, carefully designed behavior management program to make it work. See the action steps on the next page for the basics, but note that you may need to get a pro to

WHEN YOU NEED HELP WITH BEHAVIORAL SLEEP DIFFICULTIES

Behavioral sleep difficulties often don't clear up on their own. When they go on for a long time, there is a significant danger that they'll become entrenched. Professional counselors can help you choose from among a number of possible formal behavioral training programs. These include:

- positive routines
- unmodified extinction
- graduated extinction
- extinction with parental presence

They all work about equally well so you can work with a psychologist or counselor trained in behavioral medicine to choose the one you want to try and set up a formal program. You can start by trying to set up a program of your own, following the action steps on page 110; then, if that doesn't improve matters, get professional guidance.

guide you through setting it up and troubleshooting. The good news: the counseling need not be very intensive. Another recent study found improvement after parents received just two sessions of expert guidance on getting a behavioral sleep program in place.

✓ **AT A GLANCE**

Action Steps for Good Sleep Hygiene

Basics

- No TV in the bedroom.
- Turn off and remove blue light (all screens including cell phones) for at least an hour before bedtime; no use of cell phones in the bed.
- Avoid large meals right before bedtime.
- Keep the bedroom, or at least the bed, only for sleeping; study elsewhere.
- No vigorous exercise for at least an hour before bed; keep things calm and low key.
- Set up a routine that takes 30–45 minutes.
- Keep the child moving forward during the routine; redirect as necessary.
- Conclude with a very positive ritual enjoyable to the child (for example, a story or song together).
- End the routine with good night and the child in bed alone, drowsy but awake (so he doesn't think he needs you present to fall asleep the rest of the way).

Tips

- If the child calls you back or leaves the room, minimize engagement and redirect to sleep.
- Maintain total consistency, with the same routine and schedule every night.
- The best rewards are praise and affection—keep it positive.

- But use points if you have to in order to keep the child motivated to follow the routine.
- Write out the schedule if that helps the child target what you want.
- Counselors can help you create a stronger, more formal behavioral plan if needed.

FAQ: IS ADHD MEDICATION CAUSING MY CHILD TO HAVE SLEEP PROBLEMS?

A systematic review of the literature in 2015 evaluated this question. While it was disappointing how few high-quality studies have really been conducted (only nine studies on 246 children—meaning one large study could overturn the result), important interim conclusions nonetheless emerged. It appears that prescriptions of stimulant medication are associated with a greater chance of

- later sleep onset (child takes longer to fall asleep). Indeed, some reviews find that 25–50 percent of children with ADHD have some type of problem with getting to sleep on time.
- shorter sleep duration—kids get less sleep.
- reduced sleep quality (evaluated by overnight studies with electrical sensors to measure respiration, sleep stage, and other variables).

For children who must take stimulants, certain factors reduced these problems. First, the longer a child was on stimulants, the more her body adjusted and sleep got closer to normal. Thus, monitor sleep but give it a few weeks to see if your child's body adjusts back to normal sleep.

Second, the dosing schedule made a difference. It may help to ask your doctor to try a different dosing schedule, medication at a different time of day, or skipping an evening dose. Alternatively, instead of a long-acting or timed-release preparation, use a traditional short-acting compound to see if that removes the sleep interference effect.

When stimulants like Concerta or Adderall are prescribed, sleep should be tracked. This can be done by filling out a simple sleep diary or sleep log for a period of time (examples are easily found online at the National Sleep Foundation website, for example, *https://sleepfoundation.org/sleep-diary/SleepDiaryv6.pdf*).

Primary Sleep Disorders and ADHD

In addition to getting on a good sleep schedule and practicing good sleep hygiene to address the behavioral side of sleep, sleep itself has to be good quality. Poor sleep habits like watching TV before bed can cause insomnia as well as poor quality of sleep when sleeping. However, insomnia or poor sleep quality can also be caused by a primary sleep disorder related to something biological. If the behavioral steps just covered aren't cutting it, or if your child has the warning signs mentioned below, then a sleep specialist consultation is a good idea.

In 2015 researchers looking at ADHD and sleep completed a pooled analysis of studies using motion sensors on wrists and ankles to evaluate sleep. They identified twenty-four relevant studies involving over 2,100 children. That review showed that in fact children with ADHD on average do have worse sleep, with less time in deep sleep. Some of these problems will be a primary sleep disorder. While the motion sensors give a good indication something is wrong, the gold standard is *polysomnography* (studies in sleep labs), mentioned earlier. Because polysomnography studies are costly, generalizable studies are few. But the picture from what we do have still is notable. *While most kids with ADHD have behavioral sleep issues, such as not getting to bed on time, only a small percentage have true primary sleep disorders.* Still, it's important to know about these if your child has ADHD.

Delayed Sleep–Wake Phase Syndrome. Among the primary sleep disorders, the most common, and the one that is raising the most concern in relation to ADHD in the current science, is this one (formerly called *delayed sleep phase syndrome)*. Ask your doctor if you suspect this problem. (Most of the time the doctor can make the diagnosis by interview and exam. In rare instances the doctor may want to obtain saliva samples to measure melatonin production.) The solution may be as simple as a revised schedule to help your child's body realign with the light cycle or another behavioral program. In other cases, a melatonin supplement may be helpful (see the box on the facing page). As mentioned earlier, professional help is necessary to diagnose this, particularly with adolescents, for whom evolution has already pushed the sleep–wake phase far out of sync with our modern school schedules, making diagnosis more difficult. That said, here are the signs you can watch for:

FAQ: SHOULD I TRY MELATONIN FOR MY CHILD WITH ADHD?

What Is Melatonin? Melatonin is a hormone that regulates the daily circadian (wake–sleep) cycle. The body makes more melatonin when it gets dark to prepare us to sleep, and less when it gets light to prepare us to be awake. Melatonin is widely used to help adults with insomnia. It is a hormone, so even though it is sold over the counter, side effect risks are real.

Guidance. Use melatonin with your child only under medical supervision and after a behavioral program fails. Based on the proceedings of a consensus conference of experts in 2014, melatonin, properly dosed, can be safe and effective to help children fall asleep (shorter "sleep latency") and sleep longer. However, it does not reduce nighttime awakenings—it helps kids fall asleep but not *stay* asleep. Genetic variation in how they metabolize melatonin leads to better effects at lower doses for some people. Note that many over-the-counter tablets provide far too high a dose for children.

Does It Help ADHD? In the case of ADHD, the consensus conference identified only three randomized trials; each showed a benefit to sleep onset but *not* to ADHD symptoms during the day.

Risks. We have insufficient knowledge of the risks of long-term melatonin supplements for children's still-developing endocrine system. Concerns about affecting your child's development are particularly notable with infants (their bodies are still learning how to adjust sleep and melatonin to local light cycles) and teens (whose bodies are working with rapidly changing hormone levels already).

Side Effects. Though not usual, side effects can include waking up in the middle of the night, a morning "hangover" (feeling drowsy, headache, feeling "down"), daytime laziness, excessive sweating at night or in the day, and bedwetting.

Bottom Line. Melatonin can be a useful way to help restore your child to a normal sleep cycle, especially if he is diagnosed with sleep–wake phase disorder and behavior adjustments have not worked. But poor sleep hygiene, depression, or health problems can mimic a sleep–wake phase disorder, so fix sleep hygiene and get a health checkup with your pediatrician first. Because melatonin is a hormone and its interactions with normal hormone changes in developing children are not well understood, work with your doctor.

WANT TO READ MORE?

For the 2014 consensus conference report, see the following article:

Bruni, O., Alonso-Alconada, D., Besag, F., Biran, V., Braam, W., Cortese, S., et al. (2015). Current role of melatonin in pediatric neurology: Clinical recommendations. *European Journal of Paediatric Neurology, 19*(2), 122–133.

- Not being sleepy at night
- Not being able to fall asleep at bedtime
- Struggling to wake up in the morning
- Sometimes tired or sleepy during the day (or naps or sleeps easily during the day)

Other Primary Sleep Disorders. The other common disorders include *obstructive sleep apnea* and *periodic limb movements*. Obstructive apnea is more likely in individuals who are overweight. Periodic limb movements occur often in children with *restless legs syndrome*; iron deficiency can contribute to restless legs syndrome and periodic limb movements. For an individual child, the only definite way to identify a primary sleep problem is polysomnography.

Warning Signs of a Primary Sleep Disorder. Warning signs are not diagnostic, but they can help you decide whether your child might need a professional sleep evaluation. Watch for these signs in your child:

- Snores frequently even when not sick.
- Bedcovers frequently end up on the floor—even when it's cold.
- Is hanging half off the bed while sleeping (suggesting a lot of restless movement in sleep).
- Sleepwalks or has night terrors (wakes up screaming) more than once or twice.
- Can't wake up or resists getting up despite enough (apparent) sleep.

TAKE-HOME POINTS

Sleep and ADHD

- Blue screens interfere with sleep; limiting them helps sleep and creates more time for free play and exercise.
- Try to improve your child's sleep hygiene behaviorally first; that may do the trick for your child. Excellent self-help resources are

available online from the National Sleep Foundation (*https://sleepfoundation.org*).

- If you are struggling to get your child's bedtime-related behavior into a positive place or suspect a sleep disorder, seek a professional evaluation.

Keep in mind that a healthy lifestyle is synergistic. It helps all children and helps physical and emotional health. If your child has ADHD, your reduced margin for error means these are very attractive options to take advantage of. And each action step you decide to take is likely to boost the effects of the others. As noted in the take-home points for exercise, a good diet provides more fuel for exercising. So too, exercise and sleep are a virtuous cycle—one promotes the other. As you read through this book, think about what seems likely to help your child most, as well as what will be most practical for your family. The last chapter in the book will give you a chance to review all these ideas and choose the scientifically sound tools that will work for your child.

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