NEW YORK TIMES BESTSELLER

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— USA Today

brain rules

12 Principles for Surviving and Thriving at Work, Home, and School

JOHN MEDINA

Includes link to Brain Rules film
Rule #1
Exercise boosts brain power.
IF THE CAMERAS WEREN'T ROLLING and the media abuzz with live reports, it is possible nobody would have believed the following story:

A man had been handcuffed, shackled and thrown into California’s Long Beach Harbor, where he was quickly fastened to a floating cable. The cable had been attached at the other end to 70 boats, bobbing up and down in the harbor, each carrying a single person. Battling strong winds and currents, the man then swam, towing all 70 boats (and passengers) behind him, traveling 1.5 miles to Queen’s Way Bridge. The man, Jack La Lanne, was celebrating his birthday.

He had just turned 70 years old.

Jack La Lanne, born in 1914, has been called the godfather of the American fitness movement. He starred in one of the longest-running exercise programs produced for commercial television. A prolific inventor, La Lanne designed the first leg-extension machines, the first cable-fastened pulleys, and the first weight selectors, all now
standard issue in the modern gym. He is even credited with inventing an exercise that supposedly bears his name, the Jumping Jack. La Lanne is now in his mid-90s, and even these feats are probably not the most interesting aspect of this famed bodybuilder’s story.

If you ever have the chance to hear him in an interview, your biggest impression will be not the strength of his muscles but the strength of his mind. La Lanne is mentally alert, almost beyond reason. His sense of humor is both lightening fast and improvisatory. “I tell people I can’t afford to die. It will wreck my image!” he once exclaimed to Larry King. He regularly rails at the camera: “Why am I so strong? Do you know how many calories are in butter and cheese and ice cream? Would you get your dog up in the morning for a cup of coffee and a doughnut?” He claims he hasn’t had dessert since 1929. He is hyper-energized, opinionated, possessed with the intellectual vigor of an athlete in his 20s.

So it’s hard not to ask: “Is there a relationship between exercise and mental alertness?” The answer, it turns out, is yes.

**survival of the fittest**

Though a great deal of our evolutionary history remains shrouded in controversy, the one fact that every paleoanthropologist on the planet accepts can be summarized in two words:

We **moved**.

A lot. When our bountiful rainforests began to shrink, collapsing the local food supply, we were forced to wander around an increasingly dry landscape looking for more trees we could scamper up to dine. As the climate got more arid, these wet botanical vending machines disappeared altogether. Instead of moving up and down complex arboreal environments in three dimensions, which required a lot of dexterity, we began walking back and forth across arid savannahs in two dimensions, which required a lot of stamina.

“About 10 to 20 kilometers a day with men,” says famed anthropologist Richard Wrangham, “and about half that for women.”
That's the amount of ground scientists estimate we covered on a daily basis back then—up to 12 miles a day. That means our fancy brains developed not while we were lounging around but while we were working out.

The first real marathon runner of our species was a vicious predator known as Homo erectus. As soon as the Homo erectus family evolved, about 2 million years ago, he started moving out of town. Our direct ancestors, Homo sapiens, rapidly did the same thing, starting in Africa 100,000 years ago and reaching Argentina by 12,000 years ago. Some researchers suggest that we were extending our ranges by an unheard-of 25 miles per year.

This is an impressive feat, considering the nature of the world our ancestors inhabited. They were crossing rivers and deserts, jungles and mountain ranges, all without the aid of maps and mostly without tools. They eventually made ocean-going boats without the benefit of wheels or metallurgy, and then traveling up and down the Pacific with only the crudest navigational skills. Our ancestors constantly were encountering new food sources, new predators, new physical dangers. Along the road they routinely suffered injuries, experienced strange illnesses, and delivered and nurtured children, all without the benefit of textbooks or modern medicine.

Given our relative wimpiness in the animal kingdom (we don't even have enough body hair to survive a mildly chilly night), what these data tell us is that we grew up in top physical shape, or we didn't grow up at all. And they also tell us the human brain became the most powerful in the world under conditions where motion was a constant presence.

If our unique cognitive skills were forged in the furnace of physical activity, is it possible that physical activity still influences our cognitive skills? Are the cognitive abilities of someone in good physical condition different from those of someone in poor physical condition? And what if someone in poor physical condition were whipped into shape? Those are scientifically testable questions. The
answers are directly related to why Jack La Lanne can still crack jokes about eating dessert. In his nineties.

**will you age like jim or like frank?**

We discovered the beneficial effects of exercise on the brain by looking at aging populations. This was brought home to me by an anonymous man named Jim and a famous man named Frank. I met them both while I was watching television. A documentary on American nursing homes showed people in wheelchairs, many in their mid- to late 80s, lining the halls of a dimly lit facility, just sitting around, seemingly waiting to die. One was named Jim. His eyes seemed vacant, lonely, friendless. He could cry at the drop of a hat but otherwise spent the last years of his life mostly staring off into space. I switched channels. I stumbled upon a very young-looking Mike Wallace. The journalist was busy interviewing architect Frank Lloyd Wright, at the time in his late 80s. I was about to hear a most riveting interview.

“When I walk into St. Patrick’s Cathedral … here in New York City, I am enveloped in a feeling of reverence,” said Wallace, tapping his cigarette. The old man eyed Wallace. “Sure it isn’t an inferiority complex?”

“Just because the building is big and I’m small, you mean?”

“Yes.”

“I think not.”

“I hope not.”

“You feel nothing when you go into St. Patrick’s?”

“Regret,” Wright said without a moment’s pause, “because it isn’t the thing that really represents the spirit of independence and the sovereignty of the individual which I feel should be represented in our edifices devoted to culture.”

I was dumbfounded by the dexterity of Wright’s response. In four sentences, one could detect the clarity of his mind, his unshakable vision, his willingness to think out of the box. The rest of his
interview was just as compelling, as was the rest of Wright's life. He completed the designs for the Guggenheim Museum, his last work, in 1957, when he was 90 years old.

But I also was dumbfounded by something else. As I contemplated Wright's answers, I remembered Jim from the nursing home. *He was the same age as Wright.* In fact, most of the residents were. I suddenly was beholding two types of aging. Jim and Frank lived in roughly the same period of time. But one mind had almost completely withered, while the other remained as incandescent as a light bulb. What was the difference in the aging process between men like Jim and the famous architect? This question has bugged the research community for a long time. Investigators have known for years that some people age with energy and pizazz, living productive lives well into their 80s and 90s. Others appear to become battered and broken by the process, and often they don't survive their 70s. Attempts to explain these differences led to many important discoveries, which I have grouped as answers to six questions.

1) *Is there one factor that predicts how well you will age?*

It was never an easy question for researchers to answer. They found many variables, from nature to nurture, that contributed to someone's ability to age gracefully. That's why the scientific community met with both applause and suspicion a group of researchers who uncovered a powerful environmental influence. In a result that probably produced a smile on Jack La Lanne's face, one of the greatest predictors of successful aging was the presence or absence of a sedentary lifestyle. Put simply, if you are a couch potato, you are more likely to age like Jim, if you make it to your 80s at all. If you have an active lifestyle, you are more likely to age like Frank Lloyd Wright and much more likely to make it to your 90s.

The chief reason for the difference seemed to be that exercise improved cardiovascular fitness, which in turn reduced the risk for diseases such as heart attacks and stroke. But researchers wondered
why the people who were aging “successfully” also seemed to be more mentally alert. This led to the obvious second question:

2) Were they?

Just about every mental test possible was tried. No matter how it was measured, the answer was consistently yes: A lifetime of exercise can result in a sometimes astonishing elevation in cognitive performance, compared with those who are sedentary. Exercisers outperform couch potatoes in tests that measure long-term memory, reasoning, attention, problem-solving, even so-called fluid-intelligence tasks. These tasks test the ability to reason quickly and think abstractly, improvising off previously learned material in order to solve a new problem. Essentially, exercise improves a whole host of abilities prized in the classroom and at work.

Not every weapon in the cognitive arsenal is improved by exercise. Short-term memory skills, for example, and certain types of reaction times appear to be unrelated to physical activity. And, while nearly everybody shows some improvement, the degree of benefit varies quite a bit among individuals. Most important, these data, strong as they were, showed only an association, not a cause. To show the direct link, a more intrusive set of experiments had to be done. Researchers had to ask:

3) Can you turn Jim into Frank?

The experiments were reminiscent of a makeover show. Researchers found a group of couch potatoes, measured their brain power, exercised them for a period of time, and re-examined their brain power. They consistently found that when couch potatoes are enrolled in an aerobic exercise program, all kinds of mental abilities begin to come back online. Positive results were observed after as little as four months of activity. It was the same story with school-age children. In one recent study, children jogged for 30 minutes two or three times a week. After 12 weeks, their cognitive performance
1. EXERCISE

had improved significantly compared with pre-jogging levels. When the exercise program was withdrawn, the scores plummeted back to their pre-experiment levels. Scientists had found a direct link. Within limits, it does appear that exercise can turn Jim into Frank, or at least turn Jim into a sharper version of himself.

As the effects of exercise on cognition became increasingly obvious, scientists began fine-tuning their questions. One of the biggest—certainly one dearest to the couch-potato cohort—was: What type of exercise must you do, and how much of it must be done to get the benefit? I have both good news and bad news.

4) What’s the bad news?

Astonishingly, after years of investigation in aging populations, the answer to the question of how much is not much. If all you do is walk several times a week, your brain will benefit. Even couch potatoes who fidget show increased benefit over those who do not fidget. The body seems to be clamoring to get back to its hyperactive Serengeti roots. Any nod toward this history, be it ever so small, is met with a cognitive war whoop. In the laboratory, the gold standard appears to be aerobic exercise, 30 minutes at a clip, two or three times a week. Add a strengthening regimen and you get even more cognitive benefit.

Of course, individual results vary, and no one should embark on a rigorous program without consulting a physician. Too much exercise and exhaustion can hurt cognition. The data merely point to the fact that one should embark. Exercise, as millions of years traipsing around the backwoods tell us, is good for the brain. Just how good took everyone by surprise, as they answered the next question.

5) Can exercise treat brain disorders?

Given the robust effect of exercise on typical cognitive performance, researchers wanted to know if it could be used to treat atypical performance. What about diseases such as age-related
dementia and its more thoroughly investigated cousin, Alzheimer’s disease? What about affective disorders such as depression? Researchers looked at both prevention and intervention. With experiments reproduced all over the world, enrolling thousands of people, often studied for decades, the results are clear. Your lifetime risk for general dementia is literally cut in half if you participate in leisure-time physical activity. Aerobic exercise seems to be the key. With Alzheimer’s, the effect is even greater: Such exercise lowers your odds of getting the disease by more than 60 percent.

How much exercise? Once again, a little goes a long way. The researchers showed you have to participate in some form of exercise just twice a week to get the benefit. Bump it up to a 20-minute walk each day, and you can cut your risk of having a stroke—one of the leading causes of mental disability in the elderly—by 57 percent.

The man most responsible for stimulating this line of inquiry did not start his career wanting to be a scientist. He wanted to be an athletics coach. His name is Dr. Steven Blair, and he looks uncannily like Jason Alexander, the actor who portrayed George Costanza on the old TV sitcom Seinfeld. Blair’s coach in high school, Gene Bissell, once forfeited a football game after discovering that an official had missed a call. Even though the league office balked, Bissell insisted that his team be declared the loser, and the young Steven never forgot the incident. Blair writes that this devotion to truth inspired his undying admiration for rigorous, no-nonsense, statistical analysis of the epidemiological work in which he eventually embarked. His seminal paper on fitness and mortality stands as a landmark example of how to do work with integrity in this field. The rigor of his findings inspired other investigators. What about using exercise not only as prevention, they asked, but as intervention, to treat mental disorders such as depression and anxiety?

That turned out to be a good line of questioning. A growing body of work now suggests that physical activity can powerfully affect the course of both diseases. We think it’s because exercise regulates the
release of the three neurotransmitters most commonly associated with the maintenance of mental health: serotonin, dopamine, and norepinephrine. Although exercise cannot substitute for psychiatric treatment, the role of exercise on mood is so pronounced that many psychiatrists have begun adding a regimen of physical activity to the normal course of therapy. But in one experiment with depressed individuals, rigorous exercise was actually substituted for antidepressant medication. Even when compared against medicated controls, the treatment outcomes were astonishingly successful. For both depression and anxiety, exercise is beneficial immediately and over the long term. It is equally effective for men and women, and the longer the program is deployed, the greater the effect becomes. It is especially helpful for severe cases and for older people.

Most of the data we have been discussing concern elderly populations. Which leads to the question:

6) Are the cognitive blessings of exercise only for the elderly?

As you ratchet down the age chart, the effects of exercise on cognition become less clear. The biggest reason for this is that so few studies have been done. Only recently has the grumpy scientific eye begun to cast its gaze on younger populations. One of the best efforts enrolled more than 10,000 British civil servants between the ages of 35 and 55, examining exercise habits and gracing them as low, medium, or high. Those with low levels of physical activity were more likely to have poor cognitive performance. Fluid intelligence, the type that requires improvisatory problem-solving skills, was particularly hurt by a sedentary lifestyle. Studies done in other countries have confirmed the finding.

If only a small number of studies have been done in middle-age populations, the number of studies saying anything about exercise and children is downright microscopic. Though much more work needs to be done, the data point in a familiar direction, though perhaps for different reasons.
To talk about some of these differences, I would like to introduce you to Dr. Antronette Yancey. At 6 foot 2, Yancey is a towering, beautiful presence, a former professional model, now a physician-scientist with a deep love for children and a broad smile to buttress the attitude. She is a killer basketball player, a published poet, and one of the few professional scientists who also makes performance art. With this constellation of talents, she is a natural to study the effects of physical activity on developing minds. And she has found what everybody else has found: Exercise improves children. Physically fit children identify visual stimuli much faster than sedentary ones. They appear to concentrate better, Brain-activation studies show that children and adolescents who are fit allocate more cognitive resources to a task and do so for longer periods of time.

“Kids pay better attention to their subjects when they’ve been active,” Yancey says. “Kids are less likely to be disruptive in terms of their classroom behavior when they’re active. Kids feel better about themselves, have higher self-esteem, less depression, less anxiety. All of those things can impair academic performance and attentiveness.”

Of course, there are many ingredients to the recipe of academic performance. Finding out which components are the most important—especially if you want improvement—is difficult enough. Finding out whether exercise is one of those choice ingredients is even tougher. But these preliminary findings show that we have every reason to be optimistic about the long-term outcomes.

an exercise in road-building

Why exercise works so well in the brain, at a molecular level, can be explained by competitive food eaters—or, less charitably, professional pigs. There is an international association representing people who time themselves on how much they can eat at a given event. The association is called the International Federation of Competitive Eating, and its crest proudly displays the slogan (I am not making this up) In Voro Veritas—literally, “In Gorging, Truth.”
Like any sporting organization, competitive food eaters have their heroes. The reigning gluttony god is Takeru “Tsunami” Kobayashi. He is the recipient of many eating awards, including the vegetarian dumpling competition (83 dumplings downed in 8 minutes), the roasted pork bun competition (100 in 12 minutes), and the hamburger competition (97 in 8 minutes). Kobayashi also is a world champion hot-dog eater. One of his few losses was to a 1,089-pound Kodiak bear. In a 2003 Fox televised special called Man vs. Beast, the mighty Kobayashi consumed only 31 bunless dogs compared with the ursine’s 50, all in about 2½ minutes. Kobayashi lost his hot-dog crown in 2007 to Joey Chestnut, who ate 66 hot dogs in 12 minutes (the Tsunami could manage only 63).

But my point isn’t about speed. It’s about what happens to all of those hot dogs after they slide down the Tsunami’s throat. As with any of us, his body uses its teeth and acid and wormy intestines to tear the food apart and, if need be, reconfigure it.

This is done for more or less a single reason: to turn foodstuffs into glucose, a type of sugar that is one of the body’s favorite energy resources. Glucose and other metabolic products are absorbed into the bloodstream via the small intestines. The nutrients travel to all parts of the body, where they are deposited into cells, which make up the body’s various tissues. The cells seize the sweet stuff like sharks in a feeding frenzy. Cellular chemicals greedily tear apart the molecular structure of glucose to extract its sugary energy. This energy extraction is so violent that atoms are literally ripped asunder in the process.

As in any manufacturing process, such fierce activity generates a fair amount of toxic waste. In the case of food, this waste consists of a nasty pile of excess electrons shredded from the atoms in the glucose molecules. Left alone, these electrons slam into other molecules within the cell, transforming them into some of the most toxic substances known to humankind. They are called free radicals. If not quickly corralled, they will wreak havoc on the innards of a cell.
and, cumulatively, on the rest of the body. These electrons are fully capable, for example, of causing mutations in your very DNA.

The reason you don’t die of electron overdose is that the atmosphere is full of breathable oxygen. The main function of oxygen is to act like an efficient electron-absorbing sponge. At the same time the blood is delivering foodstuffs to your tissues, it is also carrying these oxygen sponges. Any excess electrons are absorbed by the oxygen and, after a bit of molecular alchemy, are transformed into equally hazardous—but now fully transportable—carbon dioxide. The blood is carried back to your lungs, where the carbon dioxide leaves the blood and you breathe it out. So, whether you are a competitive eater or a typical one, the oxygen-rich air you inhale keeps the food you eat from killing you.

Getting food into tissues and getting toxic electrons out obviously are matters of access. That’s why blood has to be everywhere inside you. Serving as both wait staff and haz-mat team, any tissue without enough blood supply is going to starve to death—your brain included. That’s important because the brain’s appetite for energy is enormous. The brain represents only about 2 percent of most people’s body weight, yet it accounts for about 20 percent of the body’s total energy usage—about 10 times more than would be expected. When the brain is fully working, it uses more energy per unit of tissue weight than a fully exercising quadricep. In fact, the human brain cannot simultaneously activate more than 2 percent of its neurons at any one time. More than this, and the glucose supply becomes so quickly exhausted that you will faint.

If it sounds to you like the brain needs a lot of glucose—and generates a lot of toxic waste—you are right on the money. This means the brain also needs lots of oxygen-soaked blood. How much food and waste can the brain generate in just a few minutes? Consider the following statistics. The three requirements for human life are food, drink, and fresh air. But their effects on survival have very different timelines. You can live for 30 days or so without food,
and you can go for a week or so without drinking water. Your brain, however, is so active that it cannot go without oxygen for more than 5 minutes without risking serious and permanent damage. Toxic electrons over-accumulate because the blood can't deliver enough oxygen sponges. Even in a healthy brain, the body's delivery system can be improved. That's where exercise comes in. It reminds me of a seemingly mundane little insight that literally changed the history of the world.

The man with the insight was named John Loudon McAdam. McAdam, a Scottish engineer living in England in the early 1800s, noticed the difficulty people had trying to move goods and supplies over hole-filled, often muddy, frequently impassable dirt roads. He got the splendid idea of raising the level of the road using layers of rock and gravel. This immediately made the roads more stable, less muddy, and less flood-prone. As county after county adopted his process, now called macadamization, an astonishing after-effect occurred. People instantly got more dependable access to one another's goods and services. Offshoots from the main roads sprang up, and pretty soon entire countrysides had access to far-flung points using stable arteries of transportation. Trade grew. People got richer. By changing the way things moved, McAdam changed the way we lived. What does this have to do with exercise? McAdam's central notion wasn't to improve goods and services, but to improve access to goods and services. You can do the same for your brain by increasing the roads in your body, namely your blood vessels, through exercise. Exercise does not provide the oxygen and the food. It provides your body greater access to the oxygen and the food. How this works is easy to understand.

When you exercise, you increase blood flow across the tissues of your body. This is because exercise stimulates the blood vessels to create a powerful, flow-regulating molecule called nitric oxide. As the flow improves, the body makes new blood vessels, which penetrate deeper and deeper into the tissues of the body. This allows
more access to the bloodstream’s goods and services, which include food distribution and waste disposal. The more you exercise, the more tissues you can feed and the more toxic waste you can remove. This happens all over the body. That’s why exercise improves the performance of most human functions. You stabilize existing transportation structures and add new ones, just like McAdam’s roads. All of a sudden, you are becoming healthier.

The same happens in the human brain. Imaging studies have shown that exercise literally increases blood volume in a region of the brain called the dentate gyrus. That’s a big deal. The dentate gyrus is a vital constituent of the hippocampus, a region deeply involved in memory formation. This blood-flow increase, which may be the result of new capillaries, allows more brain cells greater access to the blood’s food and haz-mat teams.

Another brain-specific effect of exercise recently has become clear, one that isn’t reminiscent of roads so much as of fertilizer. At the molecular level, early studies indicate that exercise also stimulates one of the brain’s most powerful growth factors, BDNF. That stands for Brain Derived Neurotrophic Factor, and it aids in the development of healthy tissue. BDNF exerts a fertilizer-like growth effect on certain neurons in the brain. The protein keeps existing neurons young and healthy, rendering them much more willing to connect with one another. It also encourages neurogenesis, the formation of new cells in the brain. The cells most sensitive to this are in the hippocampus, inside the very regions deeply involved in human cognition. Exercise increases the level of usable BDNF inside those cells. The more you exercise, the more fertilizer you create—at least, if you are a laboratory animal. There are now suggestions that the same mechanism also occurs in humans.

**we can make a comeback**

All of the evidence points in one direction: Physical activity is cognitive candy. We can make a species-wide athletic comeback.
All we have to do is move. When people think of great comebacks, athletes such as Lance Armstrong or Paul Hamm usually come to mind. One of the greatest comebacks of all time, however, occurred before both of these athletes were born. It happened in 1949 to the legendary golfer Ben Hogan.

Prickly to the point of being obnoxious (he once quipped of a competitor, “If we could have just screwed another head on his shoulders, he would have been the greatest golfer who ever lived”), Hogan’s gruff demeanor underscored a fierce determination. He won the PGA championship in 1946 and in 1948, the year in which he was also named PGA Player of the Year. That all ended abruptly. On a foggy night in the Texas winter of 1949, Hogan and his wife were hit head-on by a bus. Hogan fractured every bone that could matter to a golfer: collar bone, pelvis, ankle, rib. He was left with life-threatening blood clots. The doctors said he might never walk again, let alone play golf. Hogan ignored their prognostications. A year after the accident, he climbed back onto the green and won the U.S. Open. Three years later, he played one of the most successful single seasons in professional golf. He won five of the six tournaments he entered, including the first three major championships of the year (a feat now known as the Hogan Slam). Reflecting on one of the greatest comebacks in sports history, he said in his typically spicy manner, “People have always been telling me what I can’t do.” He retired in 1971.

When I reflect on the effects of exercise on cognition and the things we might try to recapture its benefits, I am reminded of such comebacks. Civilization, while giving us such seemingly forward advances as modern medicine and spatulas, also has had a nasty side effect. It gave us more opportunities to sit on our butts. Whether learning or working, we gradually quit exercising the way our ancestors did. The result is like a traffic wreck.

Recall that our evolutionary ancestors were used to walking up to 12 miles per day. This means that our brains were supported for most
of our evolutionary history by Olympic-caliber bodies. We were not used to sitting in a classroom for 8 hours at a stretch. We were not used to sitting in a cubicle for 8 hours at a stretch. If we sat around the Serengeti for 8 hours—heck, for 8 minutes—we were usually somebody’s lunch. We haven’t had millions of years to adapt to our sedentary lifestyle. That means we need a comeback. Removing ourselves from such inactivity is the first step. I am convinced that integrating exercise into those 8 hours at work or school will not make us smarter. It will only make us normal.

ideas

There is no question we are in an epidemic of fatness, a point I will not belabor here. The benefits of exercise seem nearly endless because its impact is systemwide, affecting most physiological systems. Exercise makes your muscles and bones stronger, for example, and improves your strength and balance. It helps regulate your appetite, changes your blood lipid profile, reduces your risk for more than a dozen types of cancer, improves the immune system, and buffers against the toxic effects of stress (see Chapter 8). By enriching your cardiovascular system, exercise decreases your risk for heart disease, stroke, and diabetes. When combined with the intellectual benefits exercise appears to offer, we have in our hands as close to a magic bullet for improving human health as exists in modern medicine. There must be ways to harness the effects of exercise in the practical worlds of education and business.

Recess twice a day

Because of the increased reliance on test scores for school survival, many districts across the nation are getting rid of physical education and recess. Given the powerful cognitive effects of physical activity, this makes no sense. Yancey, the model-turned-physician/scientist/basketball player, describes a real-world test:

“They took time away from academic subjects for physical
education ... and found that, across the board, [physical education] did not hurt the kids' performance on the academic tests. ... [When] trained teachers provided the physical education, the children actually did better on language, reading and the basic battery of tests.”

Cutting off physical exercise—the very activity most likely to promote cognitive performance—to do better on a test score is like trying to gain weight by starving yourself. What if a school district inserted exercise into the normal curriculum on a regular basis, even twice a day? After all of the children had been medically evaluated, they'd spend 20 to 30 minutes each morning on formal aerobic exercise; in the afternoon, 20 to 30 minutes on strengthening exercises. Most populations studied see a benefit if this is done only two or three times a week. If it worked, there would be many ramifications. It might even reintroduce the notion of school uniforms. Of what would the new apparel consist? Simply gym clothes, worn all day long.

*Treadmills in classrooms and cubicles*

Remember the experiment showing that when children aerobically exercised, their brains worked better, and when the exercise was withdrawn, the cognitive gain soon plummeted? These results suggested to the researchers that the level of fitness was not as important as a steady increase in the oxygen supply to the brain (otherwise the improved mental sharpness would not have fallen off so rapidly). So they did another experiment. They found that supplemental oxygen administered to young healthy adults without exercise gave a similar cognitive improvement.

This suggests an interesting idea to try in a classroom (don't worry, it doesn't involve oxygen doping to get a grade boost). What if, during a lesson, the children were not sitting at desks but walking on treadmills? Students might listen to a math lecture while walking 1 to 2 miles per hour, or study English on treadmills fashioned to
accommodate a desktop. Treadmills in the classroom might harness the valuable advantages of increasing the oxygen supply naturally and at the same time harvest all the other advantages of regular exercise. Would such a thing, deployed over a school year, change academic performance? Until brain scientists and education scientists get together to show real-world benefit, the answer is: Nobody knows.

The same idea could apply at work, with companies installing treadmills and encouraging morning and afternoon breaks for exercise. Board meetings might be conducted while people walked 2 miles per hour. Would that improve problem-solving? Would it alter retention rates or change creativity the same way it does in the laboratory?

The idea of integrating exercise into the workday may sound foreign, but it's not difficult. I put a treadmill in my own office, and I now take regular breaks filled not with coffee but with exercise. I even constructed a small structure upon which my laptop fits so I can write email while I exercise. At first, it was difficult to adapt to such a strange hybrid activity. It took a whopping 15 minutes to become fully functional typing on my laptop while walking 1.8 miles per hour.

I'm not the only one thinking along these lines. Boeing, for example, is starting to take exercise seriously in its leadership-training programs. Problem-solving teams used to work late into the night; now, all work has to be completed during the day so there's time for exercise and sleep. More teams are hitting all of their performance targets. Boeing's vice president of leadership has put a treadmill in her office as well, and she reports that the exercise clears her mind and helps her focus. Company leaders are now thinking about how to integrate exercise into working hours.

There are two compelling business reasons for such radical ideas. Business leaders already know that if employees exercised regularly, it would reduce health-care costs. And there's no question that cutting in half someone's lifetime risk of a debilitating stroke or Alzheimer's disease is a wonderfully humanitarian thing to do. But exercise
also could boost the collective brain power of an organization. Fit employees are capable of mobilizing their God-given IQs better than sedentary employees. For companies whose competitiveness rests on creative intellectual horsepower, such mobilization could mean a strategic advantage. In the laboratory, regular exercise improves—sometimes dramatically so—problem-solving abilities, fluid intelligence, even memory. Would it do so in business settings? What types of exercise need to be done, and how often? That's worth investigating.
Summary

Rule #1
Exercise boosts brain power.

- Our brains were built for walking—12 miles a day!
- To improve your thinking skills, move.
- Exercise gets blood to your brain, bringing it glucose for energy and oxygen to soak up the toxic electrons that are left over. It also stimulates the protein that keeps neurons connecting.
- Aerobic exercise just twice a week halves your risk of general dementia. It cuts your risk of Alzheimer’s by 60 percent.

Get illustrations, audio, video, and more at www.brainrules.net