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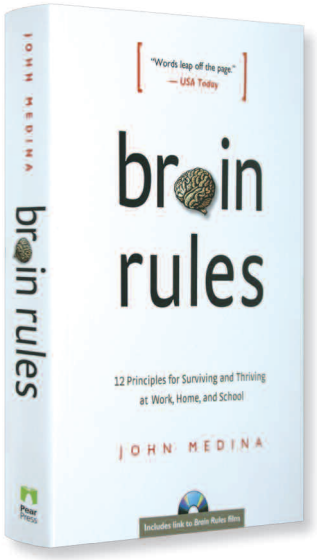
Career & Self-Development: Business Skills

Brain Rules

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



by John Medina

THE SUMMARY IN BRIEF

Most of us have no idea what's really going on inside our heads. Yet brain scientists have uncovered details every business leader, parent and teacher should know — such as the brain needs physical activity to work at its best.

How do we learn? What exactly do sleep and stress do to our brains? Why is multitasking a myth? Why is it so easy to forget — and so important to repeat new knowledge? Is it true that men and women have different brains?

In *Brain Rules*, molecular biologist John Medina shares his lifelong interest in how the brain sciences might influence the way we teach our children and the way we work. He introduces 12 "Brain Rules" — which cover what scientists know for sure about how our brains work — and then offers ideas for investigating how each rule might apply to our daily lives, especially at work and school.

Medina identifies "the brain's performance envelope" and looks at subjects that relate to this envelope, including exercise, survival, wiring, attention, memory, sleep, stress, vision, gender and exploration.

In the end, you'll better understand how your brain really works — and how to get the most out of it.

IN THIS SUMMARY, YOU WILL LEARN:

- Why our brains need physical activity as much or more than our bodies.
- Why you've got seconds to grab someone's attention and only 10 minutes to keep it.
- How taking a nap might make you more productive and mentally agile.
- Why those in neuroscience, education and business need to work together to develop improvements in both teaching and management methods.
- Why the differences between men's and women's brains start with how they got that way in the first place.

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THE COMPLETE SUMMARY: **BRAIN RULES**

by John Medina

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Brain Rules by John Medina. Copyright © 2008 by John J. Medina. Summarized with permission of the publisher, Pear Press. 301 pages. $15.00. ISBN: 978-0-9797777-4-5. To purchase this book, go to www.amazon.com or www.bn.com.

For additional information on the author, go to http://www.summary.com and http://www.brainrules.com.

Introduction

Go ahead and multiply the number 8,388,628 x 2 in your head. Can you do it in a few seconds? There is a young man who can double that number 24 times in the space of a few seconds. He gets it right every time.

There is a boy who can tell you the precise time of day at any moment, even in his sleep. There is a girl who can correctly determine the exact dimensions of an object 20 feet away. There is a child who at age 6 drew such lifelike and powerful pictures that she got her own gallery on Madison Avenue. Yet none of these children could be taught to tie their shoes. Indeed, none of them have an IQ greater than 50.

The brain is an amazing thing.

To accomplish the miracle of reading, for example, your brain sends jolts of electricity crackling through hundreds of miles of wires composed of brain cells so small that thousands of them could fit into the period at the end of a sentence.

What's equally incredible, given our intimate association with our brains, is that most of us have no idea how our brains work.

Strange Consequences

This has strange consequences. We try to talk on our cell phones and drive at the same time, even though it is literally impossible for our brains to multitask when it comes to paying attention. We have created high-stress office environments, even though a stressed brain is significantly less productive. Our schools are designed so that most real learning has to occur at home.

Blame it on the fact that brain scientists rarely have a conversation with teachers and business professionals, education majors and accountants, superintendents and CEOs. ●

EXERCISE — Rule #1: Exercise Boosts Brain Power

From an evolutionary perspective, our brains developed while working out, walking as many as 12 miles a day. The brain still craves that experience, especially in sedentary populations like our own. That's why exercise boosts brain power.

Exercisers outperform couch potatoes in long-term memory, reasoning, attention, and problem-solving tasks. Integrating exercise into our eight hours at work or school would only be normal.

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. ●

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SURVIVAL — Rule #2: The Human Brain Evolved, Too

The brain appears to be designed to solve problems related to surviving in an unstable outdoor environment and to do so in nearly constant motion. The brain adapted this way as a survival strategy to help us live long enough to pass our genes to the next generation.

Ecosystems are harsh, crushing life as easily as supporting it. Scientists estimate 99.99 percent of all species that have ever lived are extinct today. Our bodies, brains included, latched on to any genetic adaptation that helped us survive.

There are two ways to beat the cruelty of the environment: You can become stronger or you can become smarter. Humans chose the latter. It seems most improbable that such a physically weak species could take over the planet not by adding muscles to our skeletons but by adding neurons to our brains.

But we did, and scientists have spent a great deal of effort trying to figure out how.

Judy DeLoache, a researcher at the University of Virginia, has studied this question extensively. She is especially interested in how human cognition can be distinguished from the way other animals think about their respective worlds.

Symbolic Reasoning

One of DeLoache's major contributions was to identify the human trait that really does separate us from the gorillas: the ability to use symbolic reasoning. When we see a five-sided geometric shape, we're not stuck perceiving it as a pentagon. We can just as easily perceive the U.S. military headquarters or a Chrysler minivan. Our brain can behold a symbolic object as real all by itself and yet, simultaneously, also representing something else.

DeLoache calls it Dual Representational Theory. Stated formally, it describes our ability to attribute characteristics and meanings to things that don't actually possess them. Stated informally, we can make things up that aren't there. We are human because we can fantasize.

Symbolic reasoning is a uniquely human talent. It may have arisen from our need to understand one another's intentions and motivations, allowing us to coordinate within a group.

Meet Your Brain

The prefrontal cortex is only the newest addition to the brain. Three brains are tucked inside your head, and parts of their structure took millions of years to design. (This "triune theory of the brain" is one of several models scientists use to describe the brain's overarching structural organization.)

Your most ancient neural structure is the brain stem, or ***lizard brain***. This rather insulting label reflects the fact that the brain stem functions the same in you as in a gila monster. The brain stem controls most of your body's housekeeping chores. Its neurons regulate breathing, heart rate, sleeping and waking.

Sitting atop your brain stem is what looks like a sculpture of a scorpion carrying a slightly puckered egg on its back. The ***Paleomammalian brain*** appears in you the same way it does in many mammals, such as house cats, which is how it got its name. It has more to do with your animal survival than with your human potential.

Several parts of this "second brain" play a large role in

Jack LaLanne: Godfather of the American Fitness Movement

A man was 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 LaLanne, was celebrating his birthday. He had just turned 70 years old.

LaLanne, 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, LaLanne designed the first leg-extension machines, the first cable-fastened pulleys, and the first weight selectors, all now standard issue in the modern gym.

To hear him in an interview, your biggest impression would be not the strength of his muscles but the strength of his mind. LaLanne is mentally alert, almost beyond reason. His sense of humor is both lightening fast and improvisatory. He is hyper-energized, opinionated and 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.

the Brain Rules. The claw of the scorpion, called the amygdale, allows you to feel rage, fear or pleasure, or experience memories of rage, fear or pleasure. The amygdale is responsible for both the creation of emotions and the memories they generate.

The leg attaching the claw to the body of the scorpion is called the hippocampus. The hippocampus converts your short-term memories into longer-term forms. The scorpion's tail curls over an egg-shaped structure like the letter "C" — as if protecting it.

This "egg" is the thalamus, one of the most active, well-connected parts of the brain — a control tower for the senses. Sitting squarely in the center of your brain, it processes signals sent from nearly every corner of your sensory universe, then routes them to specific areas throughout your brain.

Arching above like a cathedral is your ***human brain***, the cortex. Latin for "bark," the cortex is the surface of your brain. It is in deep electrical communication with the interior.

This "skin" ranges in thickness from that of blotting paper to that of heavy-duty cardboard. It appears to have been crammed into a space too small for its surface area. Indeed, if your cortex were unfolded, it would be about the size of a baby blanket.

WIRING — Rule #3: Every Brain Is Wired Differently

The human brain, only partially constructed at birth, will not be fully assembled for years. The biggest construction programs aren't finished until you are in your early 20s, with fine-tuning well into your mid-40s.

When babies are born, their brains have about the same number of connections as adults have. That doesn't last long. By the time children are 3 years old, the connections in specific regions of their brains have doubled or even tripled. This doubling and tripling doesn't last long, either. The brain soon takes thousands of tiny pruning shears and trims back a lot of this hard work.

By the time children are 8 or so, they're back to their adult numbers. And if kids never went through puberty, that would be the end of the story. In fact, it is only the middle of the story.

At puberty, the whole thing starts over again. Quite different regions in the brain begin developing. Once again, you see frenetic neural outgrowth and furious pruning back. It isn't until parents begin thinking about college financial aid for their high schoolers that the children's brains begin to settle down to their adult forms (sort of). It's like a double-humped camel. From a connectivity point of view there is a great deal of activity in the terrible twos and then, during the terrible teens, a great deal more.

Whether examining toddlers or teenagers, different regions in different children develop at different rates.

Ideas

Given these data, does it make any sense to have school systems that expect every brain to learn like every other? Does it make sense to treat everybody the same in business, especially in a global economy replete with various cultural experiences? The data offer powerful implications for how we should teach kids — and, when they grow up and get a job, how we should treat them as employees.

Smaller Class Size — All else being equal, it has been known for many years that smaller, more intimate schools create better learning environments than megaplex houses of learning. Given that every brain is wired differently, being able to read a student's mind is a powerful tool in the hands of a teacher.

Theory of Mind, defined as the ability to understand the interior motivations of someone else and the ability to construct a predictable theory of how their mind works based on that knowledge, gives teachers critical access to their students' interior educational life.

Customized Instruction — To create more individualized instruction within a grade level, a three-pronged research effort between brain and education scientists is suggested:

1. Evaluate teachers for advanced Theory of Mind skills, using one of the four main tests that measure empathy. Determine whether this affects student performance in a statistically valid fashion.
2. Develop adaptive software for a variety of subjects and grade levels.
3. Test both ideas in various combinations. Add to the mix environments where the student-teacher ratio is both typical and optimized, and then compare the results.

The reason to do this is straightforward: You cannot change the fact that the human brain is individually wired. Every student's brain, every employee's brain, every customer's brain is wired differently.

What you do and learn in life physically changes what your brain looks like — it literally rewires it.

ATTENTION — Rule #4: We Don't Pay Attention to Boring Things

The more attention the brain pays to a given stimulus, the more elaborately the information will be encoded and retained. This has implications for your employees, your students and your kids.

But peer-reviewed studies confirm that before the first quarter-hour is over in a typical presentation, people have usually checked out. The brain seems to be making choices according to some stubborn timing pattern, undoubtedly influenced by both culture and gene. This fact suggests a teaching and business imperative: Find a way to arouse and then hold somebody's attention for a specific period of time.

The messages that do grab our attention are connected to memory, interest and awareness.

In everyday life, we use previous experience to predict where we should pay attention. Different environments create different expectations. The brain continuously scans the sensory horizon, with events constantly assessed for their potential interest or importance. The more important events are then given extra attention.

Emotionally arousing events tend to be better remembered than neutral events. Studies show that emotional arousal focuses attention on the "gist" of an experience at the expense of peripheral details.

Of course, at work and at school, detailed knowledge is often critical for success. Interestingly, our reliance on gist may actually be fundamental to finding a strategy for remembering details.

Whether you are a waiter or brain scientist, if you want to get the particulars correct, don't start with details. Start with the key ideas and, in a hierarchical fashion, form the details around these larger notions.

The Brain Cannot Multitask

Multitasking, when it comes to paying attention, is a myth. We are biologically incapable of processing attention-rich inputs simultaneously. We must jump from one thing to another. It is time-consuming and it is sequential. That's why people find themselves losing track of previous progress and needing to "start over," perhaps muttering things like "Now where was I?" each time they switch tasks.

The best you can say is that people who appear to be good at multitasking actually have good working memories, capable of paying attention to several inputs *one at a time.*

SHORT-TERM MEMORY — Rule #5: Repeat to Remember

Hermann Ebbinghaus was born in 1850 and is famous for uncovering one of the most depressing facts in all of education: People usually forget 90 percent of what they learn in a class within 30 days. He further showed that the majority of this forgetting occurs within the first few hours after class. This has been robustly confirmed in modern times.

Ebbinghaus's work was foundational. It was also incomplete. It did not, for example, separate the notion of memory from retrieval — the difference between learning something and recalling it later.

There are two types of memories: memories that involve conscious awareness and memories that don't. This awareness distinction gradually morphed into the idea that there were memories you could declare and there were memories you could not declare.

Declarative memories are those that can be experienced in our conscious awareness, such as "this shirt is green," "Jupiter is a planet," or even a list of words. Nondeclarative memories are those that cannot be experienced in our conscious awareness, such as the motor skills necessary to ride a bike.

This does not explain everything about human memory. It does not even explain everything about declarative memory. But the rigor of Ebbinghaus gave future scientists their first real shot at mapping behavior onto a living brain. Research shows that the life cycle of declarative memory can be divided into four sequential steps: encoding, storing, retrieving and forgetting.

Cracking the Code

Despite their wide reach, scientists have found that all encoding processes have common characteristics. Three of these hold true promise for real-world applications in both business and education:

- The more elaborately we encode information at the moment of learning, the stronger the memory.
- A memory trace appears to be stored in the same parts of the brain that perceived and processed the initial input.
- Retrieval may best be improved by replicating the conditions surrounding the initial encoding.

What does it mean to make encoding and retrieving environments equivalent in the real world of business and education? The most robust findings occur when the environments exist in dramatically different contexts from the norm. But how different from normal life does

the setup need to be to obtain the effect?

It could be as simple as making sure that an oral examination is studied for orally, rather than by reviewing written material. Or perhaps future airplane mechanics should be taught about engine repair in the actual shop where the repairs will occur.

LONG-TERM MEMORY — Rule #6: Remember to Repeat

We now suspect that short-term memory is actually a collection of temporary memory capacities. Each capacity specializes in processing a specific type of information. Each operates in a parallel fashion with the others. To reflect this multifaceted talent, short-term memory is now called working memory.

Working memory is known to be a busy, temporary workspace, a desktop the brain uses to process newly acquired information.

The process of converting short-term memory traces to longer, sturdier forms is called consolidation. At first, a memory trace is flexible, labile, subject to amendment and at great risk for extinction. Most of the inputs we encounter in a given day fall into this category. But some memories stick with us. Initially fragile, these memories strengthen with time and become remarkably persistent.

Memory may not be fixed at the moment of learning, but repetition, doled out in specifically timed intervals, is the fixative.

The relationship between repetition and memory is clear. Deliberately re-expose yourself to the information more elaborately, and in fixed, spaced intervals, if you want the retrieval to be the most vivid it can be. Learning occurs best when new information is incorporated gradually into the memory store rather than when it is jammed in all at once.

Long-term memories are formed in a two-way conversation between the hippocampus and the cortex, until the hippocampus breaks the connection and the memory is fixed in the cortex — which can take years.

Perhaps learning in the long view should be thought of the same way one thinks of immune booster shots, with critical pieces of information being repeated on a yearly or semi-yearly basis.

SLEEP — Rule #7: Sleep Well, Think Well

In 1965, 17-year-old Randy Gardner decided that his science-fair project would involve not sleeping for 11 straight days and observing what happened. To the astonishment of just about everyone, he accomplished the feat, setting a world record that year for sleep loss. The project attracted the attention of scientist William Dement, who was given permission to study what happened to the teenager's mind during the week and a half he was awake. What happened to Randy's mind was extraordinary.

To put it charitably, it started to malfunction.

In short order, he became irritable, forgetful, nauseous and, to no one's surprise, unbelievably tired. Five days into his experiment, Randy began to suffer from what could pass for Alzheimer's disease. He was actively hallucinating, severely disoriented and paranoid. He thought a local radio host was out to get him because of his changes in memory.

In the last four days of his experiment, he lost motor function, his fingers trembling and his speech slurred. Curiously, on the final day, he still was able to beat Dement at pinball, doing so 100 consecutive times.

So we know bad things happen when we don't get any sleep. But we still don't know why we need to sleep.

Sleep Loss = Brain Drain

When you look at all of the data combined, a consistency emerges: Sleep is rather intimately involved in learning. It is observable with large amounts of sleep; it is observable with small amounts of sleep; it is observable all the time.

Some kind of offline processing is occurring at night. Is it possible that the reason we need to sleep is simply to shut off the exterior world for a while, allowing us to divert more attentional resources to our cognitive interiors? Is it possible that the reason we need to sleep is so that we can learn?

Here's what we do know:

- The brain is in a constant state of tension between cells and chemicals that try to put you to sleep and cells and chemicals that try to keep you awake.
- The neurons of your brain show vigorous rhythmical activity when you're asleep — perhaps replaying what you learned that day.
- People vary in how much sleep they need and when they prefer to get it, but the biological drive for an afternoon nap is universal.
- Loss of sleep hurts attention, executive function, working memory, mood, quantitative skills, logical reasoning and even motor dexterity.

STRESS — Rule #8: Stressed Brains Don't Learn the Same Way

You can feel your body responding to stress: Your pulse races, your blood pressure rises and you feel a massive release of energy. That's the famous hormone adrenaline at work. The overall effect is called the fight or flight response. But there's a less famous hormone at work, too — also released by the adrenals, and just as powerful. It's called cortisol. It's the second wave of our defensive reaction to stressors and, in small doses, it wipes out most unpleasant aspects of stress, returning us to normalcy.

Stress hormones can do some truly nasty things to your brain if boatloads of the stuff are given free access to your central nervous system. That's what's going on when you experience chronic stress.

Under chronic stress, adrenaline creates scars in your blood vessels that can cause a heart attack or stroke, and cortisol damages the cells of the hippocampus, crippling your ability to learn and remember.

Three things matter in determining whether a workplace is stressful: the type of stress, a balance between occupational stimulation and boredom, and the condition of the employee's home life. The perfect storm of occupational stress appears to be a combination of two malignant facts: a) a great deal is expected of you and b) you have no control over whether you will perform well.

To detect stress-related problems, one might simply examine the situations where an employee feels the most helpless. The next step would be to change the situation. This might change the absentee rate of employees, cut down on the number of trips to the doctor and reduce insurance overhead.

As well as money saved, a great deal of creativity may be engendered simply by routinely giving employees a way out — not from their jobs, but from the stress they experience in them.

SENSORY INTEGRATION — Rule #9: Stimulate More of the Senses

External physical inputs and internal emotional inputs all are presented to your brain in a never-ending fire hose of sensations. As in a normal morning in Manhattan for example, your brain perceives the screech of the taxis, the pretzels for sale, the crosswalk signal and the people brushing past. Snapshots like these illustrate the incredible amount of sensory information your brain must process simultaneously.

We absorb information about an event through our senses, translate it into electrical signals (some from sight, others from sound, etc.), disperse those signals to separate parts of the brain, then reconstruct what happened, eventually perceiving the event as a whole.

There is no question that multiple cues, dished up via different senses, enhance learning. They speed up responses, increase accuracy, improve stimulation detection and enrich encoding at the moment of learning.

Our senses evolved to work together — vision influencing hearing, for example — which means we learn best if we stimulate several senses at once.

VISION — Rule #10: Vision Trumps All Other Senses

We do not see with our eyes. We see with our brains. What we see is only what our brain tells us we see, and it's not 100 percent accurate. We actually experience our visual environment as a fully analyzed *opinion* about what the brain thinks is out there.

The visual analysis we do has many steps. The retina assembles photons into little movie-like streams of information. The visual cortex processes these streams, some areas registering motion, others registering color, etc. Finally, we combine that information back together so we can see.

If you think the brain has to devote a lot of its precious thinking resources to vision, you are right on the money. It takes up about half of everything you do, in fact. Vision is probably the best single tool we have for learning anything.

Pictures — Worth a Thousand Words

When it comes to memory, researchers have known for more than 100 years that pictures and text follow very different rules. Put simply, the more visual the input becomes, the more likely it is to be recognized and recalled. The phenomenon is so pervasive, it has been given its own name: the pictorial superiority effect, or PSE.

Text and oral presentations are not just less efficient than pictures for retaining certain types of information; they are *way* less efficient. If information is presented orally, people remember about 10 percent, tested 72 hours after exposure. That figure goes up to 65 percent if you add a picture.

One of the reasons text is less capable than pictures is that the brain sees words as lots of tiny pictures. Even when we read, most of us try to visualize what the text

is telling us. Pictorial information may be initially more attractive to consumers, in part because it takes less effort to comprehend. Because it is also a more efficient way to glue information to a neuron, there may be strong reasons for entire marketing departments to think seriously about making pictorial presentations their primary way of transferring information.

We learn and remember best through pictures, not through written or spoken words. ●

GENDER — Rule #11: Male and Female Brains are Different

There is a great deal of confusion regarding the way men and women relate to each other, and even more about why. The differences between men's and women's brains start with how they got that way in the first place.

The X Factor

If you have two X chromosomes, you go into the ladies' locker room all your life; an X and Y puts you forever in the men's. The Y can be donated only by sperm (the egg never carries one), so the male determines the sex.

Labs have found differences in the front and prefrontal cortex areas of the brain that control much of our decision-making ability. This cortex is fatter, in certain parts, in women than in men.

Women are genetically more complex, because the active X chromosomes in their cells are a mix of Mom's and Dad's. Men's X chromosomes all come from Mom, and their Y chromosome carries less than 100 genes, compared with about 1,500 for the X chromosome.

Men's and women's brains are different structurally and biochemically — men have a bigger amygdale and produce serotonin faster, for example — but we don't know if those differences have significance.

Men and women respond differently to acute stress: Women activate the left hemisphere's amygdale and remember the emotional details. Men use the right amygdale and get the gist.

Dealing with the emotional lives of men and women is a big part of the job for teachers and business professionals. They need to know:

1. Emotions are useful. They make the brain pay attention.
2. Men and women process certain emotions differently.
3. The differences are a product of complex interactions between nature and nurture. ●

EXPLORATION — Rule #12: We Are Powerful and Natural Explorers

Babies are the model of how we learn — not by passive reaction to the environment but by active testing through observation, hypothesis, experiment and conclusion. Specific parts of the brain allow this scientific approach. The right prefrontal cortex looks for errors in our hypothesis ("The saber-toothed tiger is not harmless"), and an adjoining region tells us to change behavior ("Run!").

We can recognize and imitate behavior because of "mirror neurons" scattered across the brain. Mirror neurons are cells whose activity reflect their surroundings. Cues that can elicit mirror neural responses are remarkably subtle. Classic imitative behavior is when you stick your tongue out at a baby and the baby imitates you. Other neurons mirror a variety of motor behaviors.

Researchers have shown that some regions of the adult brain stay as malleable as a baby's brain, so we can grow new connections, strengthen existing connections and even create new neurons, allowing all of us to be lifelong learners.

For little ones, discovery brings joy. It is a straight-up reward system that, if allowed to flourish, will continue into the school years. As children get older, they find that learning not only brings them joy, but it also brings them mastery. Expertise in specific subjects breeds the confidence to take intellectual risks.

The Sense of Wonder

The greatest Brain Rule of all is the importance of curiosity. Classrooms and businesses should be designed with the brain in mind. If we started over, curiosity would be the most vital part of both demolition crew and reconstruction crew. ●

RECOMMENDED READING LIST

If you liked *Brain Rules*, you'll also like:

1. ***Sway* by Ori Brafman and Rom Brafman.** We are all prone to irrational behavior, but understanding why it occurs can help us to become more aware of it. This book helps you resist the pull of irrational behavior.
2. ***Buyology* by Martin Lindstrom.** Lindstrom presents the astonishing findings from his groundbreaking neuromarketing study that peered inside the brains of two thousand volunteers.
3. ***A Whole New Mind* by Daniel H. Pink.** Right-brain thinking controls the more artistic, creative side of the mind and is becoming more important to business. Learn the six essential aptitudes you'll need in order to excel.