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Foreword

Medical school professors who have a sense of history will sometimes tell their students that half of what they are learning is wrong—but that we don't yet know which half that will turn out to be. Medical knowledge has been evolving and changing for a long time, whether or not its teachers knew it (or would admit it). In the fourth century BCE, Aristotle thought that the seat of intelligence was in the heart. The blood carried the hot emotions, and the role of the brain was to cool it. Human brains cooled more than smaller animal brains did, making humans more rational. That's not the way we think the brain works today.

Now, fast-forward almost up to the present. As a medical student, I recall reading an old article on the neuroanatomical basis of emotion and memory. This article has stood the test of time: it laid the foundation upon which our current understanding of this area is based. I was shocked, however, to find a sentence in it which would not have made it past the scientific reviewers even in my school days- saying, in effect, that "We don't know what this part of the brain does, but since it's bigger in men than in women we assume it must have something to do with sex."

If all this isn't enough of a challenge, there's also the problem of how fast new information accumulates. When I was in college many years ago, one of my chemistry professors described a study which had been done to look at the production of new information in the field. It concluded that if someone spent forty hours a week doing nothing but reading the new scientific literature as it was published,

by the end of the year she would be months behind! Today's diligent scientist would undoubtedly fare even worse.

We're bombarded all the time with news of breakthroughs and new theories about how to improve our health. Unfortunately, many of these result in conflicting advice. Is hormone replacement therapy good or bad? What about caffeine? Should I take supplements, or not? Eat butter or margarine? How much red wine should I drink with my fish? Is it safe to eat the apples yet? Will my cell phone give me brain cancer?

You don't have to go to medical school and read ponderous scientific journals all day to find a path through this heap of information. In this book, Sondra Kornblatt will guide you through it. She explains how the brain is put together, how it works, and how it influences many aspects of your life. You'll learn how it produces moods and emotions and how hormones affect it. You'll gain practical tips about supporting your brain: how to feed it, rest it, amuse it, help it repair itself, and keep it healthy. You'll learn about sleep, exercise, and diet; vitamins, supplements, and toxins; meditation and clever tricks for remembering things; and even the benefits of "yawn attacks." You'll have some laughs—and that is also good for your brain.

This book is well-researched and presents current brain science in a comprehensible way. The information here is practical and comes from both Western medical and alternative viewpoints. You don't have to be a doctor or neuroscientist to benefit from it. In thirty years as a neurologist, I've seen women of all ages who are concerned about their brain health. This book is a wonderful tool for anyone who wants to understand how to keep her brain happy and functioning at its peak for a very long time.

Jean Millican, MD
Seattle, Washington

Acknowledgments

Writing this book was like making a clay sculpture. I had to search the earth for clay, dig it, mix it, wedge it, envision it, shape it, smash it down, reshape it, simplify it, and finally glaze and fire it.

It wasn't a lonely journey. My caring community of family and friends helped me from the search for clay to the kiln. They kept me from trashing the book, my sanity, and my brain.

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And mostly to my children: Milo and Ella, thank you for your writing opinions, grocery shopping, *Glee* watching, music sharing, Sadie loving, dish wrangling, and dinner celebrations. Let me know what you think if you ever read this book. I love you.

Chapter 1

The Weary Brain

A brain is a lot like a computer. It will only take so many facts, and then it will go on overload and blow up.

Erma Bombeck, humorist

Women are overloaded.

Need proof? Look at the covers of magazines in the grocery line for the long list of things we "should" attend to.

Lose 11 pounds in 7 days. Exfoliate your skin. Buy the latest fashions. Get a flat stomach. Organize your garage. Six tips to get ahead at work. Save for retirement. Latest smart investments. Five sexy ways to make your man love you. Eat right for your unborn baby. Parenting the terrible twos. Help your children read in just ten minutes a day. Get your teens to church. Find your best new smart phone. Beware of toxins in your furniture. Choose the right Botox doctor. When to bikini wax in the winter. Cook healthy quick meals. Build a compost bin. Care for your mother across the country. Stay fit through all ages.

We're living in a world so fast paced, with so many expectations, it's really crazy. There's a limit to what the nervous system can handle, and most of us are way over the limit.[1] With demands coming from all sides, we feel like we're going to lose our minds—and perhaps our brains too.

Your brain is the center of your stormy life, but it is not like the quiet, calm eye of a hurricane. Your brain is more like a boat in a harbor, whipped around in winds and cross currents, banging against the pier, held by ropes that are straining against the stress.

You can hear it in your language**:** you say you forgot a parent-teacher conference because of *brain fog,* missed a party because you

were *brain fried,* can't retrieve the name of a book author because of a *brain fart,* or procrastinate learning a new telephone system at work because your *brain is toast*.

Poor brain. It has to orchestrate everything: muscles, hormones, digestion, mood, speech, sleep, memory, dreams, compassion, emotions, actions, and stress.

Even though it's doing all that, it's easy to take the brain for granted. You frequently don't give yourself the things your brain needs to function well: good foods, exercise, stimulating challenges, a nontoxic environment, quiet time, nature, bigger perspectives, emotional care, friends to talk with, and respect for what it's doing.

There's only so much you can change outside, but you can change what you do, including how you support the brain.

Taking care of your brain can change your life.

You and your brain need care to stay sane in this crazy world. When you support your brain, it has more resources to handle what's expected of it. You'll be more relaxed about your overwhelming to-do lists. You'll also know how to stop blaming yourself and your brain for not handling the impossible. Instead, you'll support your brain in order to get the best from it—and from your life.

Brain Fitness for Women shows you holistic ways to sustain your brain—more than just clever games that stretch your cognitive ability, like most brain-fitness books focus on. Your cognitive ability is just one part of your brain, and there are many factors that influence our brains every day: toxins, information overload, overwhelming emotions, and hormone changes.

You'll learn what revives the brain, including exercising, volunteering, socializing, and spending time in nature. *Brain Fitness for Women* shares the latest on the brain and food choices, learning, memory help, and meditation. You'll also read about:

- Triggering biophelia (attraction to nature) in your house;
- Myths about male and female brains, and what really makes them different;
- Myths about preventing Alzheimer's and what really helps;

- Toxins in your cosmetics and how to avoid them;
- How both movement and stillness improve your brain.

Some techniques may be new to you; some you may have forgotten. Some may be small steps; some may be big leaps. In all cases, the aim is to help you form a new relationship with your brain—and your life.

This book will help you appreciate and love the miracle under your skull, one that extends via communication systems throughout your body to the tips of your fingers and toes. Treat yourself and your brain in the same way you would a new love on your first dates—good dinner, stimulating activities, long walks, and quiet moments just being together.

When you care for your brain using the tips in this book, you will support how it functions, understand its human limitations, and foster a long and healthy partnership with your unique genius. (And happily, all the ways that support the brain also support the body.) The best part of your brilliant neural phenomenon: despite all the ups and downs, it can be grateful for the blessing of being alive.

So let's turn away from the headlines in those women's magazines and learn how to revive our brains and make them fit for us, in all dimensions.

Chapter 2

Brain Basics

Does Your Brain Know It's a Girl?

With modern parts atop old ones, the brain is like an iPod built around an eight-track cassette player.

Sharon Begley, journalist

If a woman has to choose between catching a fly ball and saving an infant's life, she will chose to save the infant's life without even considering if there are men on base.

Dave Barry, humorist

By the time my daughter was eight, she was pretty blasé when people mistook her for a boy, which was a fairly common occurrence. After all, my daughter usually wore a baseball (not softball) uniform or comfortable clothes from the boys' department—not pink or purple clothes with short, useless sleeves and lace. Her hair was short, her style was brisk, and it was perfectly logical that sales clerks, strangers in the park, and even new parents at school would assume she was a boy.

Even though it wasn't easy for strangers to tell that my daughter was a girl, she knew she was one. And even though it's not easy to tell if a young brain (in a lab, without the body) belongs to a boy or girl, the brain knows what it is—at least as far as basic reproduction. Beyond that, there are plenty of questions and plenty of opinions about whether our actions are hardwired into the gender of the brain.

We'll look at the brain and sex in this chapter and the next, after we understand a little bit about the miracle everyone has inside their skull.

The Basic Brain

The brain is the most complex structure on earth.[2] The physical brain—consisting of mostly water (about 78%), plus fats, proteins, and carbohydrates—can sense the outside and inner world, create thoughts and feelings, keep you breathing and pumping blood, and discover new ways to relate to the world. The brain is mind-boggling.

To understand the components of the awesome brain, let's create a model using your hands. Make two fists, touching the first knuckles together and keeping your thumbs parallel. Your combined fists are about the size of a brain.

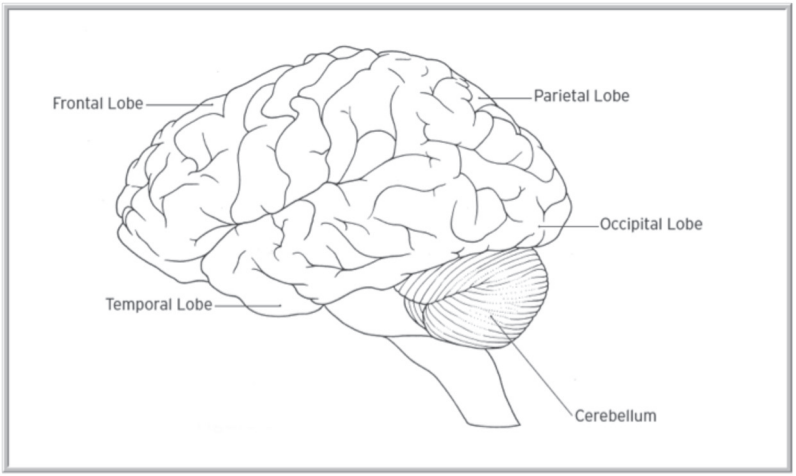
Now, imagine that between your fists is a ball of bread dough about the size of a tennis ball; inside the dough are two shelled almonds and two shelled walnuts, one of each within the dough in either fist. This dough is your *limbic* system, the oldest part of your brain; it supports basic brain functions, including emotion, behavior, and long-term memory. The two almonds together are your *amygdalae,* which govern your emotions and fight-or-flight fear response. The two walnuts represent your *thalamus,* the center for sensory and motor functions.

Now bend your arms so your elbows point to the floor and your knuckles point to the sky. If someone put a pencil between your arms, that pencil would be your spinal cord, and your wrists would be your *brain stem*. The brain stem manages basic body functions, such as heart rate and consciousness (being awake or sleepy). Combine the limbic system and brain stem (the dough ball and your wrists), and you have a pretty functional brain system for animals.

But we're missing the *cerebellum,* which you can imagine as a big blob of dough squeezed out of the back, or pinky side, of your hand, by your wrist. The cerebellum is called a "little brain." It's like a little computer that connects and coordinates motor control, cognitive functions such as attention and language, and probably some emotional responses such as fear and pleasure. The cerebellum connects to the more complex *cerebral cortex* on top of the brain.[3]

Your combined fists represent the two hemispheres of the *cerebrum* and their fissures (folds that increase the surface area of the brain).

The thumb side is the front of the brain: the *frontal lobes* responsible for reasoning, motivation, and other higher brain functions that allow you to read, drive, and play Wii Fit. The middle fingers are the *parietal lobes,* which are responsible for touch, movement, and orientation. The backs of the hands (nearest the ears in a person, if the brain were in a head) are the *temporal lobes,* responsible for auditory stimuli, memory, and speech. Finally, the pinky fingers are the *occipital lobes,* responsible for visual processing.[4]



You've got the whole world in your hands. But beyond this basic view are many more ways to slice and analyze the brain.

A Universe of Neurons

The field of neuroscience is now being compared with astronomy, because they both deal with unknowns of similar magnitude. You know how you feel the infinite expanse of the universe when you see a thick carpet of stars in a dark sky? That magnitude is echoed in our brains, which hold hundreds of trillions of synapses—1,500 times the number of stars that fill the Milky Way galaxy.

Our brains have hundreds of trillions of synapses—
1,500 times the number of stars in the Milky Way galaxy.

Information travels quickly in our brains—very quickly. The *slowest* speed that information is transferred between neurons is 260 mph. That's slightly faster than the speed of the original Bugatti EB, one of the fastest road-legal cars in the world, clocked at 253 mph.

Our brains are not only fast, but also busy. One human brain has an average of 70,000 thoughts per day and generates more electrical impulses than all the telephones in the world combined.

The most obvious magical marvels that do all this work are called **neurons,** the primary cells of our brain and nervous system. About 100 billion neurons live under your skull in your three-pound spongy ball of brilliance. Each neuron looks like a spindly tree drawn by Dr. Seuss and consists of three parts:

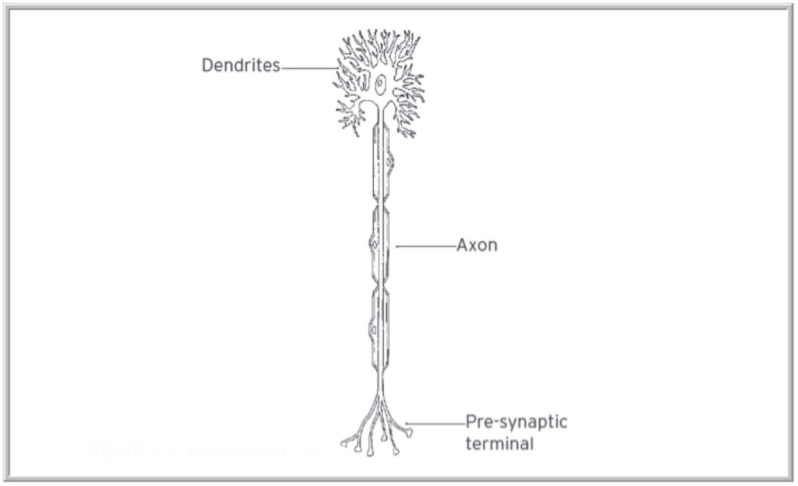
Dendrites, branches that receive input from other neurons,

Cell body, which sustains the life of the cell and contains its DNA,

Axon, a living cable that carries electrical impulses at very high speeds toward the dendrites of neighboring neurons.

A *synapse* is a junction between the axon of one neuron and the dendrite of another (or it can be between a neuron and a muscle). A synapse sends electrical or chemical (such as neurotransmitter) signals, which either excite or inhibit the chance for action. Each connection creates a weak electromagnetic field that can join together with the electromagnetic fields of other neural connections. Those combined connections increase the speed, empathy, and activity between neurons that are not in direct contact.[5]

The *glia,* or support cells for your neurons, are part of this electromagnetic "telepathy" of the brain. *Glial cells* are far more numerous than neurons, making up 90% of your brain's cells. They consume



parts of dead neurons, manufacture myelin (a white neuron coating that protects the axon and increases axon impulses up to fifty times[6]), form an immune system,[7] provide physical and nutritional support for neurons, and even communicate with other synapses.[8]

Science is learning more about glial cells, adding to knowledge about neurons. Half of glial cells are tiny *granule cells,* which hang out in the *cerebellum*. While the cerebellum (remember it's the "little brain" of dough squeezed out the back of your wrist) makes up only about 10% of the brain, it contains more nerve cells than all the rest of the brain combined and is one of the brain's most rapidly acting mechanisms.[9] It connects to the highest level of the brain, the cerebral cortex, via 40 million nerve fibers. Compare that to your optic track, which uses just 1 million to take care of seeing and reading.

The *cerebral cortex* is our gray matter, composing about 85% of the brain; it contains the lobes (frontal, parietal, temporal, and occipital). The densely packed neurons in the cerebral cortex work together to create *neural networks,* pathways of learning that constantly communicate and change.[10]

Are There Limits on Neurons?

There are two conflicting stories about our neurons: (1) we shouldn't kill our brain cells because they're the only ones we've got, and (2) neurogenesis—the birth of neurons—continues throughout our lives. What's the scoop?

Until the 1960s, scientists believed that whatever neurons we had at birth were all we'd get. But about that time, experiments on rats and monkeys showed otherwise; and still other experiments on canaries showed that they developed new brain cells when they learned new songs. Researchers wanted to know if people also developed new neurons—but since it's a little tricky to dissect the brain of a learning human, they couldn't find out that way for sure.

Move ahead thirty years to the '90s, when scientists conducted research on terminal cancer patients who were given certain drugs labeled with fluorescent dyes in their medical treatment. After the patients died, their brains were examined. The examinations showed that the patients had generated new neurons—right up until death. They indicated that the human hippocampus, a memory center of the limbic system, retains its ability to generate neurons throughout life.[11]

The Myth of Limited Brain Use

Is it true that we use only 10% of our brain? Do we have 90% that's just twiddling its proverbial thumbs, wishing it had something to do already? Does that idle 90% mean we are really psychic or could move mountains if we used it?

No, that's a myth, says neuroscientist Eric Chudler, director of education and outreach at the University of Washington and developer of the informative *Neuroscience for Kids* website.[12] Images from PET scans and MRI have shown that if someone loses 90% of her brain—or of any part of her brain—she will not just continue living as if nothing had happened. From the perspective of evolution, it does not make a whole lot of sense to build and maintain a massively underutilized organ.

Researchers still have questions about neurogenesis. New neurons in rat brains travel from the hippocampus to other parts of the brain, but researchers have not yet proven whether the same thing happens in human brains. Some camps question whether the new brain cells are neurons or glial cells and what purpose they serve.[13]

For us nonscientists, the important thing to know is that even though we get almost all our neurons at birth, our brains continue to change and grow, supporting our learning with new neurons, new connections, or both.

Connecting the Neurons

More important than how many main cells we have is how we use and connect the ones that stick around. These connections create maps (neural pathways) that constantly change as our moldable brain grows, learns, and matures. Those brain circuits that we actively maintain will remain and even grow stronger.

Your neural pathways constantly change as your brain grows, learns, and matures.

Researchers at Virginia University found that abilities based on accumulated knowledge keep increasing until age sixty.[14] However, this study's results were based on behavior, not the biology of the brain; it also does not address the effects of practice on strengthening cognition.[15]

When you take up a new hobby, like playing the guitar or knitting, your brain designates more cell power to this new activity. As you stick with it, the brain accommodates this new knowledge by changing or creating neural maps and maybe even assigning extra neurons to help. You go from remembering what fingers to use for the C-minor chord to just knowing it. What if you stop for a while? If you're a winter knitter, don't worry—those neural connections won't disappear over the summer. They just focus on something else. They'll be there next winter, though it might take them a little time to get their knit-purl connections back.

Practice may not always make perfect, but it does help you rearrange your neurons and connections. Don't worry about feeling dumb while you're learning. You're just ushering your neurons into place.

Is Your Brain a Boy or a Girl?

Here's a stunning revelation: men and women are different. But what differences are the results of nature (the brain and biology) and what differences are the results of nurture (parenting and culture)? Male and female brains have been compared for over a century, but the excitement really heated up in the past decade, as new tools have measured brain activity, sizes of brain areas, and behavioral responses.

News about the differences between men's and women's brains popped up everywhere—from John Gray's *Men Are from Mars, Women Are from Venus* and Louann Brizendine's *The Female Brain* to Discovery Health and *Newsweek*. All of these sources said that brain differences, present from birth, are what make men and women distinct. Even a former president of Harvard said that, based on brain research, women didn't have the brains for math and physics.[16]

These new discoveries were accepted by the media and public, but they were publicized without rigorous analysis. Recent scrutiny questions the validity of the studies and the hidden assumptions beneath the results.

Brain Sex Rumors

New studies of brains use functional magnetic resonance imaging (fMRI) and positron emission tomography (PET), both of which measure blood flow and produce three-dimensional imaging. Researchers compared male and female brains and compared the brains of those doing puzzles to those meditating, those looking at happy pictures or at sad ones, or those just listening or responding actively in a conversation. They've measured the sizes of brain components and the blood flow to areas that were active; the results were pictures of brains filled with bright blobs of color indicating which sections were active.

These studies aimed to show that male and female brains are significantly different at birth in many areas. Supposedly:

- Males have better right-hemisphere skills, such as those involved in art, music, and math, due to the testosterone male embryos receive; females are better at communicating, observing, and processing emotion.
- Males are better able to systematize and are more aggressive than females, also because of this infusion of testosterone in male embryos; females have more collaborative and verbal brains.
- Compared to men, women have the stronger ability to "mirror" others, feeling what others are feeling or sensing what others are thinking.
- Men have a larger amygdala, dubbed the "instinctual core of the brain," than women.
- Women worry more than men because their anterior cingulate cortex is larger.
- Women have more neurons for language processing and comprehension in the temporal lobe cortex than men have.
- The corpus callosum, a pathway of 200 to 250 million nerve fibers between the right and left hemispheres, is larger in women than in men. This greater number of cross-brain connections means women are better at activities involving both sides of the brain, and men are better at activities requiring the focus of one side or the other.

But several authors have called these studies on the carpet. They scientifically challenged whether (1) our advanced instruments tell as much as we'd like, (2) the assumptions they tell are true, and (3) the studies are large enough for their statistics to have veracity.

For instance, when looking at the corpus callosum, some studies found that it is the same size in men and women, and other studies found that it's bigger in men. Studies also question whether having a larger right hemisphere means increased learning or more difficulty learning. And while the anterior cingulate cortex is the part of the brain that generates worry, this part is also involved with a wide variety of cognitive, motor, and emotional tasks, such as decision-making;

so it makes as much sense to say that a larger anterior cingulate cortex means women think better than men, instead of that women worry more.

Cordelia Fine, author of *Delusions of Gender*, says that these studies are looking at the brain through traditional assumptions. It's just like 1915, she says, when studies "proved" that women couldn't judge political initiatives and couldn't vote, all because they had smaller upper spinal cords. The results of these studies are similarly biased because of what she calls *neurosexism*.[17]

We are starting to get larger and more valid studies about gender and the brain, which we hope will clarify the issue. And we know some consistent male-female brain differences in animals and humans from previous decades of study.

What Do We Really Know?

Boys and girls' brains are different at birth, but the differences are much smaller than we think, says Lise Eliot, PhD, in *Pink Brain, Blue Brain: How Small Differences Grow Into Troublesome Gaps—And What We Can Do About It*.[18]

In fact, before the eighth week of pregnancy, there is no male brain at all—everyone starts as a female. Around the eighth week, male embryos (meaning embryos with XY chromosomes) get a surge of testosterone. The testosterone changes the brain's original plan to create a uterus and ovaries in the female with XX chromosomes; the male embryo develops a penis and testicles instead.

Only a few physical pre-adolescent brain differences have been reliably proven to exist:

- Boys' brains are larger than girls' brains. (This difference used to support the idea that men were smarter, but when you consider the brains of elephants, the logic fades. Larger brains are needed for larger muscles and to process more sensations.[19])
- Girls' brains finish growing about one to two years earlier than boys' brains. (Hormonal differences are key in this growth difference.)

- Parts of the *hypothalamus* are different. The hypothalamus controls basic body cycles and is connected to the pituitary (or "master hormone") gland. The areas of the hypothalamus that are different in males and females control circadian rhythms and reproduction.

There may be some subtle differences in boys and girls' sensory processing, language circuits, and frontal-lobe development, but overall, boys' brains and girls' brains are remarkably similar.

So what creates more gender-typical behavior? How babies are treated, say both Eliot and Fine. Our wonderfully plastic brains respond to gender-specific atmospheres. For example, if you believe you're better at math, the area of your brain that does math work will be larger. Even intentionally unbiased child-rearing practices have some sex stereotyping, according to Fine. Add Disney movies and sports stars to the mix, and it's a challenge to separate and study the natural brain from the nurtured one.

Hormones, such as testosterone, estradiol, oxytocin, and thyroid hormone, also affect both men and women's brains, causing differences in everything from pain response to aggression and emotional responses. In the next chapter, we'll talk about how the range of hormones affects functions of the brain.

Despite the popularity of studies that say sex differences are hardwired into brain structures, right now that assertion appears to be unproven. We have so much to learn about whether and how much gender behavior is influenced by differences in brains and hormones —even the best neuroscientists are still learning.

So when you're sorting through all the latest studies mentioned on Google News or articles in *Newsweek,* withhold your wholehearted approval until you've seen multiple large-sample studies. Some research might say you were born with limitations due to your gender, but others say that's not true. If you have to choose between thinking, "Oh well, that's just the kind of person I am," or thinking "I can move beyond my limitations and perceptions," why not go for the second?

No matter what your brain holds right now, from genetics to cultural reactions to annoying habits you learned from your parents, it

has the ability to change. You can get a doctorate in diffusive biomolecular reactions, teach yourself to compartmentalize your emotional reactions, and learn the latest features on new cars—if you want.

No matter what your brain holds right now,
it has the ability to change.

No matter how you use your 125 trillion synapses, choose the path that gives you all the options you want. Then your brain will know it's working for a powerful and aware woman.