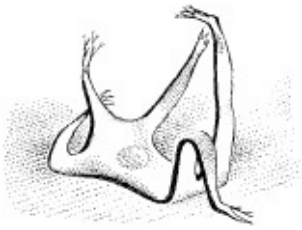
KEEP YOUR BRAIN ALIVE

83 Neurobic Exercises to Help Prevent Memory Loss and Increase Mental Fitness



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PREFACE

As the population of over 76 million Baby Boomers approaches middle age and beyond, the issue of preserving mental powers throughout greatly increased life spans has reached an almost fever pitch. There is a growing interest in—and optimism about—preserving and enhancing the brain's capabilities into senior years. With the help of powerful new tools of molecular biology and brain imaging, neuro-scientists around the world have literally been looking into the mind as it thinks. Almost daily, they are discovering that many of the negative myths about the aging brain are, indeed only myths: "Older and wiser" is not just a hopeful cliché but can be the reality. In much the same way that you can maintain your physical well-being, you can take charge of your mental health and fitness.

Although new and therefore not yet proved by a large body of tests, Neurobics is based on solid scientific ground; it is an exciting synthesis of substantial findings about the brain that provides a concrete strategy for keeping the brain fit and flexible as you grow older.

From Theory to Practice

Jane reached into her pocketbook and fished inside for the keys to her apartment. Usually they were i the outside flap pocket but not today. "Did I forget them?! No…here they are." She felt their shapes t figure out which one would open the top lock. It took her two tries until she heard the welcome click o the lock opening. Inside the door she reached to the left for the light switch…but why bother? Her husband would do that later. Touching the wall lightly with her fingertips, she moved to the closet on the right, found it, and hung up her coat. She turned slowly and visualized in her mind the location of the table holding her telephone and answering machine. Carefully she headed in that direction, guide by the feel of the leather armchair and the scent of a vase of birthday roses, anxious to avoid the sha edge of the coffee table and hoping to have some messages from her family waiting.

The table. The answering machine. She reached out and brushed her fingers across what she believed to be the play button. "What if I push the delete button?" she thought, and again checked to make sure she was right. Yesterday it was so easy. She could have done all this simply by looking around. Today was different. She could see nothing.

But Jane had not suddenly gone blind. At age 50, she was introducing a lifestyle strategy called Neurobics into her daily activities. Based on recent discoveries in brain science, Neurobics is a new form of brain exercise designed to help keep the brain agile and healthy. By breaking her usual

homecoming routine, Jane had placed her brain's attentional circuits in high gear. With her eyes closed, she had to rely on her senses of touch, smell, hearing, and spatial memory to do something they rarely did—navigate through her apartment. And she was involving her emotional sense by feeling the stresses of not being able to see. All these actions created new and different patterns of neuron activity in her brain—which is how Neurobics works.

This book will explain the principles behind Neurobics and how the exercises enhance the overall health of your brain as you grow older.

Chapter I

Neurobics: The New Science of Brain Exercise

What was the name of that actor who was in all the early Woody Allen films? You know…curly brown hair…?"

The first time you forget the name of a person you should know, a movie title, or an important meeting, you're likely to exclaim—only half-jokingly—"I'm losing it! My brain is turning to Jell-O." Reinforced by messages and images in the mass media, you equate mild forgetfulness with the first stages of accelerating mental decline.

"…He was just in a Broadway show with, um, what's-her-name. Oh, God, you know who I mean."

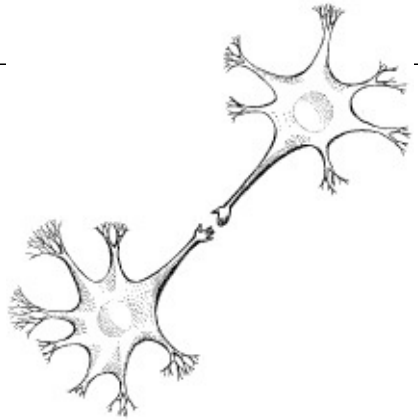
And maybe they do. But if they don't, you become frustrated and preoccupied trying to recall this buried name. Usually beginning in your forties or fifties—sometimes even in your thirties—you start to notice these small lapses: not remembering where you put the car keys or what was on the grocery list you left at home…or being unable to understand the instructions for a new VCR or computer…or forgetting where the car is parked because you left the mall through a different door.

Even though these small lapses don't actually interfere much with daily life, the anxiety they provoke can. You worry that you'll become just like your Aunt Harriet, who can remember details of events from the Depression but not what she did yesterday. Firsthand experiences with people who have difficulty with perception and memory as they age can make you anxious when you suddenly forget something ordinary. No wonder you jump to the conclusion that aging is an inevitable slide into forgetfulness, confusion, or even the first stages of Alzheimer's disease.

The good news, however, is that mild forgetfulness is not a disease like Alzheimer's and action can be taken to combat it. Recent brain research points to new approaches that can be incorporated into everyday activities to develop and maintain brain connections. By adopting these strategies, you may actually enhance your brain's ability to deal with declines in mental agility.

There are numerous myths about the aging brain that neuroscientists are disproving daily. With the help of exciting new technologies, the traditional view of the way the brain ages is being rapidly revised. Evidence clearly shows that the brain doesn't have to go into a steep decline as we get older. In fact, in 1998, a team of American and Swedish scientists demonstrated for the first time that *new brain cells are generated in adult humans.*[1]

Also contrary to popular belief, the mental decline most people experience is not due to the steady death of nerve cells.[2] Instead, it usually results from the thinning out of the number and complexity of *dendrites*, the branches on nerve cells that directly receive and process information from other nerve cells that forms the basis of memory. Dendrites receive information across connections called *synapses*. If connections aren't regularly switched on, the dendrites can atrophy. This reduces the brain's ability to put new information into memory as well as to retrieve old information.



Nerve cells need to keep communicating to stay healthy.

Growing dendrites was long thought to be possible only in the brains of children. But more recent work has shown that *old neurons can grow dendrites to compensate for losses.*[3]

Other experiments show that neural circuits in adult brains have the capacity to undergo dramatic changes—an ability scientists thought was lost after childhood. *The aging brain, however, continues to have a remarkable ability to grow, adapt, and change patterns of connections.*[4]

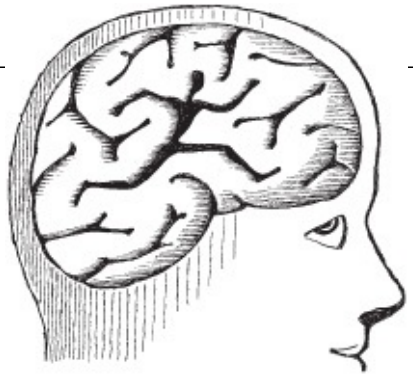
Discoveries like these are the basis of a new theory of brain exercise. Just as cross training helps you maintain overall physical fitness, Neurobics can help you take charge of your overall mental fitness.

Neurobics aims to help you maintain a continuing level of mental fitness, strength, and flexibility as you age.

The exercise program calls for presenting the brain with nonroutine or unexpected experiences using various combinations of your physical senses—vision, smell, touch, taste, and hearing—as well as your emotional "sense." It stimulates patterns of neural activity that create more connections between different brain areas and causes nerve cells to produce natural brain nutrients, called neurotrophins, that can dramatically increase the size and complexity of nerve cell dendrites.[5] Neurotrophins also make surrounding cells stronger and more resistant to the effects of aging.

Neurobics is very different from other types of brain exercise, which usually involve logic puzzles, memory exercises, and solitary practice sessions that resemble tests. Instead, Neurobic exercises use the five senses in novel ways to enhance the brain's natural drive to form associations between different types of information. Associations (putting a name together with a face, or a smell with a food, for example) are the building blocks of memory and the basis of how we learn. Deliberately creating new associative patterns is a central part of the Neurobic program.

Putting together the neuroscience findings (pages 6–7) with what scientists already know about our senses led directly to our concept of using the associative power of the five senses to harness the brain's ability to create its own natural nutrients. In short, with Neurobics you can grow your own brain food—without drugs or diet.



The word *Neurobics* is a deliberate allusion to physical exercise. Just as the ideal forms of physic exercise emphasize using many *different muscle groups* to enhance coordination and flexibility, the ideal brain exercises involve activating many *different brain areas* in novel ways to increase the rang of mental motion. For example, an exercise like swimming makes the body more fit overall and capable of taking on *any* exercise. Similarly, Neurobics makes the brain more agile and flexible overall so it can take on *any* mental challenge, whether it be memory, task performance, or creativity That's because Neurobics uses an approach based on how the brain works, not simply on how to work the brain.

THE SCIENTIFIC BASIS FOR NEUROBICS

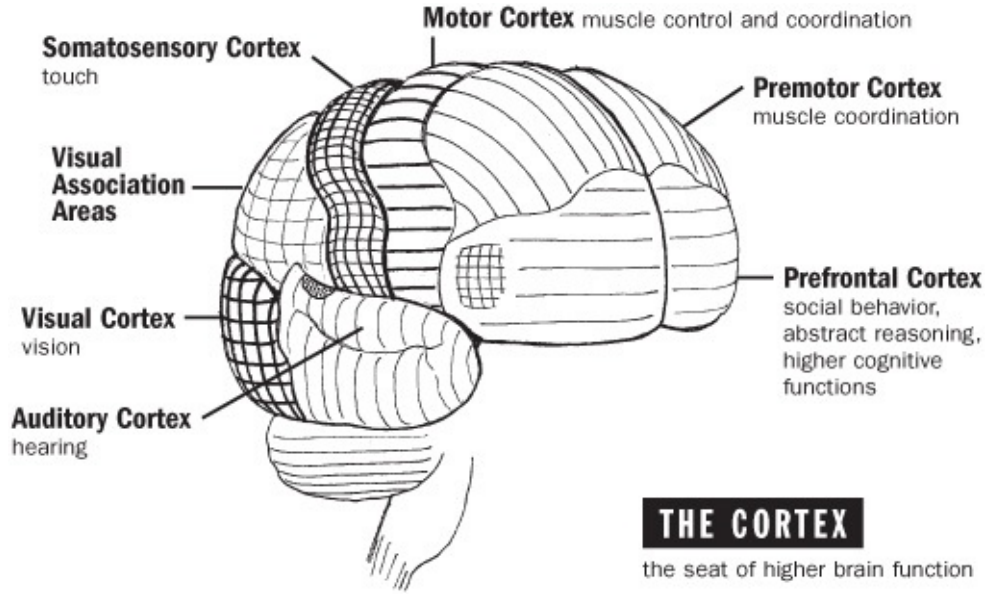
Neurobics rests on much more than a single breakthrough finding. It is a synthesis of important new information about the organization of the brain, how it acquires and maintains memories, and how certain brain activities produce natural brain nutrients. These findings include:

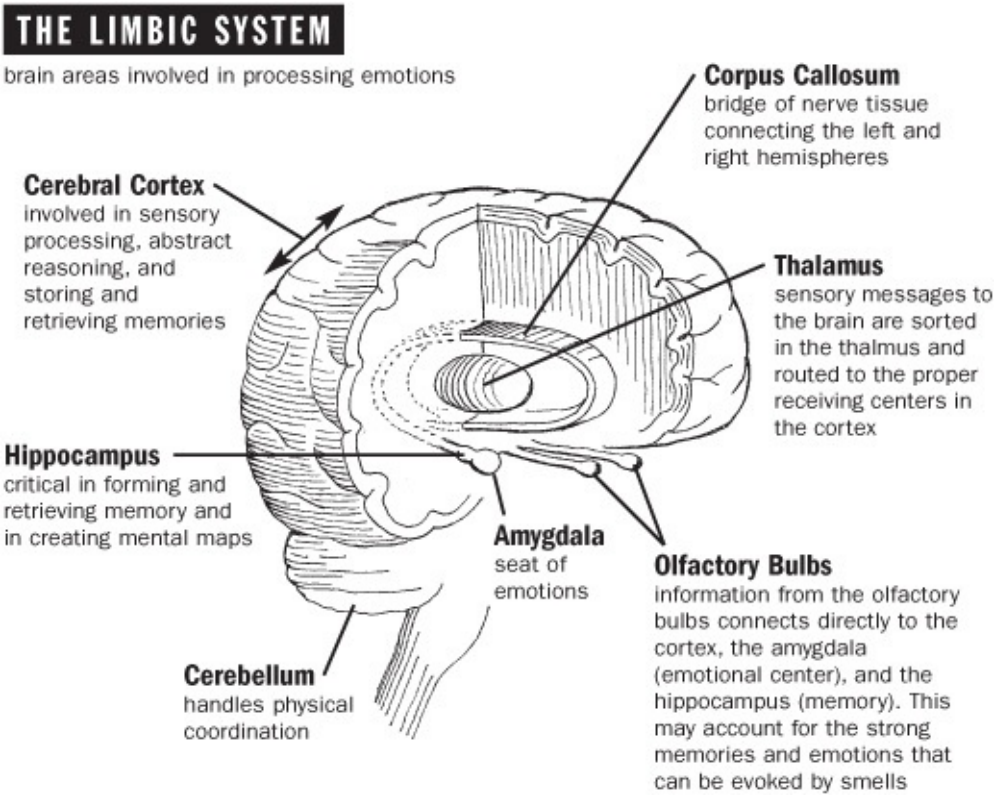
1. The cerebral cortex, the seat of higher learning in the brain, consists of an unexpectedly large number of different areas, each specialized to receive, interpret, and store information from the senses. What you experience through the senses doesn't all end up in one place in the brain.
2. Connecting the areas of the cerebral cortex are hundreds of different neural pathways, which can store memories in almost limitless combinations. Because the system is so complex and the number of possible combinations of brain pathways so vast, we employ only a small fraction of the possible combinations.
3. The brain is richly endowed with specific molecules—the neurotrophins—which are produced and secreted by nerve cells to act as a kind of brain nutrient that actually promotes the health of these nerve cells as well as the health of their neighbors and the synapses between them.[6]
4. The amount of neurotrophins produced by nerve cells— and how well nerve cells respond to neurotrophins made by other nerve cells—is regulated by how active those nerve cells are. In other words, the more active brain cells are, the more growth-stimulating molecules they produce and the better they respond.[7]
5. Specific kinds of sensory stimulation, especially nonroutine experiences that produce novel activity patterns in nerve cell circuits, can produce greater quantities of these growth-stimulating molecules.[8]

Chapter II

How the Brain Works

The brain receives, organizes, and distributes information to guide our actions and also stores important information for future use. The problems we associate with getting older— forgetfulness, not feeling “sharp,” or having difficulty learning new things—involve the cerebral cortex and the hippocampus.





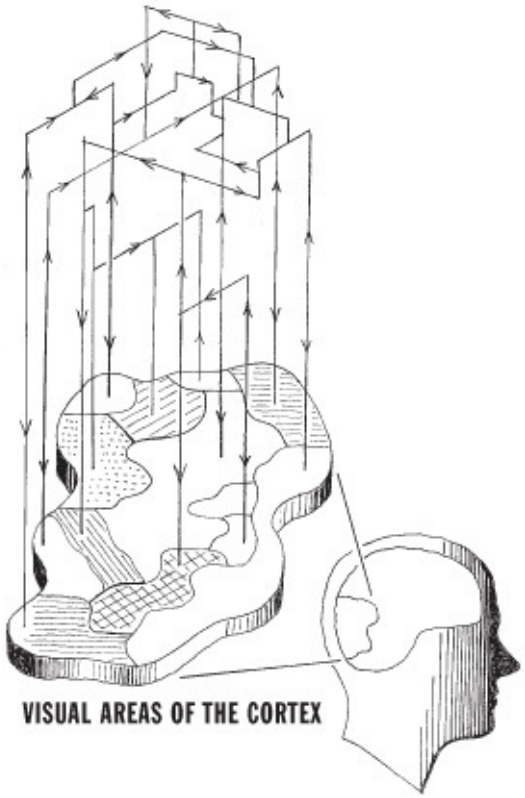
The cortex is the part of the brain that is responsible for our unique human abilities of memory, language, and abstract thought. The hippocampus coordinates incoming sensory information from the cortex and organizes it into memories. The wiring of the cortex and hippocampus is designed to form links (or associations) between different sensory representations of the same object, event, or behavior.

THE CEREBRAL CORTEX AND HIPPOCAMPUS

Most pictures of the brain usually show the deeply grooved and folded cerebral cortex: a thin sheet of cells (no thicker than twenty pages of this book) wrapped around the other "core" parts of the brain like a rind on a grapefruit. Although thin, the cortex is very large (spread out it would cover the front page of a newspaper) and contains an astounding number of nerve cells—about one hundred million in every square inch. And while the cortex may look like a uniform sheet, it actually consists of dozens, perhaps hundreds, of smaller, specialized regions (some as small as a fingernail, others as large as a credit card). Each of the senses has its own dedicated portions of cortical real estate—for example, there are at least thirty specialized areas just for vision.

Processing information as it comes in from the senses involves a network of many smaller regions. In addition, other regions of the cortex specialize in integrating information from two or more different senses (so, for example, when you hear a sound you know where to look).

These hundreds of regions are linked together by the brain's equivalent of wires: thin threads called axons (each only one hundredth the thickness of a human hair) that extend from nerve cells and conduct electrical impulses from one part of the brain to another. Every cortical region sends and receives millions of impulses via these axons to and from dozens of other cortical regions. The brain contains literally hundreds of miles of such wires. Thus, the cortex resembles an intricate web, with each region linked directly or indirectly to many other regions. Some of these connections are between areas that process similar information, such as the thirty involving vision, while other connections are between dissimilar areas, such as touch and smell. The network of pathways between cortical regions that do many different things is what allows the cortex to be so adept at forming associations.



There are 30 specialized areas in the visual cortex alone; each area links up (communicates) wit its neighbors (shown here in simplified form). A realistic diagram would show over 200 linkage

Like the cortex, the hippocampus plays an important role in forming associations. The senses continually flood the brain with information, some of it vital but much of it unimportant. You don't need to remember the face of everyone you pass on the street, but you do want to recognize someone you just met at your boss's party! To prevent the information overload that would accompany having to remember too much, the hippocampus sifts through the barrage of incoming information from the cortex and picks out what to store or discard. In other words, the hippocampus acts like a central clearinghouse, deciding what will be placed into long-term memory, and then, when called upon, retrieving it. The hippocampus's decision to store a memory is believed to hinge on two factors: whether the information has emotional significance, or whether it relates to something we already know.

The hippocampus is also vital for making mental maps, allowing us to remember things like wher our car is parked or how to get from home to work. Animals in which the hippocampus has been removed cannot learn or remember simple mazes.

Most problems that cause mental deficiencies involve the cerebral cortex or the hippocampus. So keeping mentally fit really means exercising these parts of our brain so they function at their best. And what they do best is to form associations between different kinds of information they receive.

ASSOCIATIONS: HOW WE LEARN

Associations are representations of events, people, and places that form when the brain decides to lin different kinds of information, especially if the link is likely to be useful in the future. The raw material for associations originates primarily from the five senses but also can be emotional or socia cues. The brain takes several different things into account in deciding whether to forge these mental connections. For example, if something provides inputs to two or more senses close together in time,

like the sight, smell, and taste of a cheese-burger, the brain will almost automatically link the sensations. In essence, this is our basic learning process.

The classic example of associative linking, often taught in introductory psychology courses, is Dr Ivan Pavlov's experiments with dogs. Dogs normally salivate at the sight of food. Every day when Pavlov fed the dogs, he rang a bell. After a few days, just ringing a bell made the dogs salivate, even no food was presented.

These dogs made an association—a connection within their brains—that a certain sensory stimulu (the bell) meant food. Consequently, the sound of the bell alone made the brain instruct the salivary glands to get ready for food. Humans and animals can form similar links between almost any kind of sensory inputs.

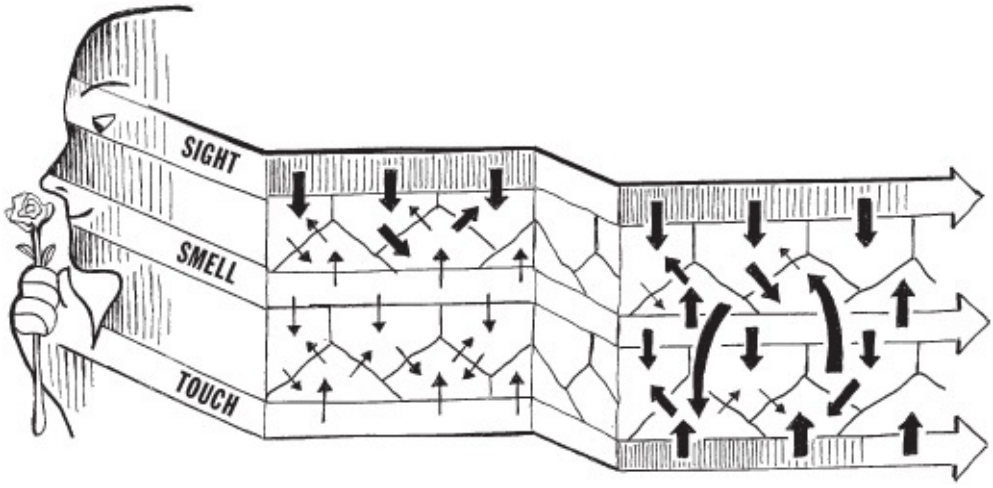
Obviously, humans are capable of much more sophisticated and abstract learning that isn't as closely tied to external stimuli (like bells) or external rewards (like food). Take learning a language, for example. An infant learns language by associating a particular set of sounds with a certain behavior, person, or object. (An explicit reward may or may not be present.)

Once such associations are formed, they reside in the brain as a long-term memory, which can be accessed just by experiencing the original stimulus. It's rather astounding when you think about it: A certain kind of sensory experience can permanently change the wiring in part of your brain!

Most of what we learn and remember relies on the ability of the brain to form and retrieve associations in much the same way as Pavlov's dogs learned that a bell meant food. For example, you pick up a rose, and its *smell* activates the olfactory (smelling) parts of the cortex, its image activates the *visual* areas, and the soft petals or sharp thorns activate the *feeling* sections. All these different sensations cause nerve cells in very different areas of the cortex to be activated at the same time in a particular pattern, strengthening some of the linkages between these areas.

Once that happens, anything that activates just part of the network will activate all the areas of the brain that have representations of rose events. Someone hands you a rose, and as you hold it, you may remember your first wedding anniversary when you received a dozen roses, which reminds you of your first apartment in that awful building with the broken elevator. Or the smell of roses reminds yo of Aunt Harriet's rose garden in late summer where you had picnics with your cousin Arnie who is now living in California and whom you keep meaning to call—all sorts of memories result from a single stimulus.

If you just see a rose, you activate only a small number of neural pathways (bold arrows, left segment) within the visual cortex.



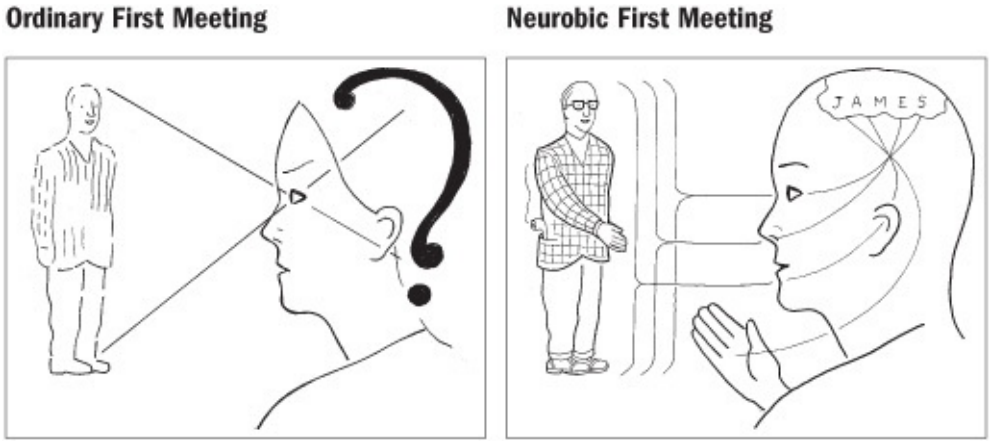
But if you smell, touch, and see a rose, a much larger number of direct and indirect pathways between the olfactory, visual, and tactile areas are activated (above, right segment). These associative linkages between senses help in memory recall.

MEMORY

Existing programs for brain exercise have ignored this powerful associative route to forming and retrieving memories. Neurobics seeks to access it by providing the cortex with the raw material that will create new and potent associations.

Because each memory is represented in many different cortical areas, the stronger and richer the network of associations or representations you have built into your brain, the more your brain is protected from the loss of any one representation.[1]

Take the common problem of remembering names. When you meet a new person, your brain link a name to a few sensory inputs, such as his appearance (visual). When the brain is younger, these few associations are strong enough so that the next time you see this person, you recall his name. But the more you age, the more people you've met, leaving fewer unique visual characteristics available to represent each new person, so the associative links between visual characteristics and names are mor tenuous. Now, imagine closing your eyes in the course of meeting someone. Sensory inputs, other tha vision, become much more important as the basis for forming associations necessary for recalling a name: the feel of his hand, his smell, the quality of his voice.



Name Recall: If you use only sight when you meet someone, you're less likely to remember his name. If, on the other hand, you use all your senses, you'll have many more associations —"thinning hair, middle-aged, glasses, hand feels like a damp, limp rag, clothes smell like a smokehouse, voice sounds like a bullfrog"—to recall his name.

You have now tagged someone's name with not just one or two associations, but at least four. If access to one associative pathway is partly blocked ("Gosh, he looks familiar"), you can tap into associations based on other senses and do an end run around the obstruction. Adopting the strategies of forming multisensory associations when the brain is still at or near its peak performance—in the forties and fifties—builds a bulwark against some of the inevitable loss of processing power later in life. If your network of associations is very large, it's like having a very tightly woven net, and the loss of a few threads isn't going to let much fall through.

These multisensory representations for tasks like remembering names were always available to

you, but early on, your brain established an effective routine for meeting people that relied primarily on visual cues. An important part of the Neurobic strategy is to help you "see" in other ways—to use other senses to increase the number and range of associations you make. The larger your "safety net," the better your chances of solving a problem or meeting a challenge because you simply have more pathways available to reach a conclusion.

More often than not, adults don't exploit the brain's rich potential for multisensory associations. Think of a baby encountering a rattle. She'll look at it closely, pick it up, and run her fingers around i shake it, listen to whether it makes a sound, and then most likely stick it in her mouth to taste and fee it with her tongue and lips. The child's rapidly growing brain uses all of her senses to develop the network of associations that will become her memory of a rattle.

Now think of yourself finding a rattle on the floor. Most likely, you'll just look at it and instantly catalog it: "It's a rattle." The point is that a child is constantly tapping into the brain's ability to strengthen and increase connections between its many regions—for smelling, touching, hearing, tasting, and seeing—to produce an ever-growing tapestry of associations…and neural activity.

Adults miss out on this multisensory experience of new associations and sensory involvement because we tend to rely heavily on only one or two senses. As we grow older, we find that life is easi and less stressful when it's predictable. So we tend to avoid new experiences and develop routines around what we already know and feel comfortable with. By doing this, we reduce opportunities for making new associations to a level that is less than ideal for brain fitness.

Simultaneous sensory input creates a neural "safety net" that traps information for future access.

ROUTINES CAN BE BRAIN-DEADENING

You may be reading this and thinking, "I lead a fairly active life and my brain seems pretty stimulated. Sure, I have my routines, but it's not like I don't see new movies, listen to new songs on the radio, watch TV, or meet new people."

The truth, however, is that most of us go through our adult lives engaged in a series of remarkably fixed routines. Think about your average week…or day-to-day life. Really, how different are your commutes, your breakfasts, lunches, and dinners, week in and week out? And what about things like shopping and laundry? It's startling to realize just how predictable and free from surprises our everyday lives really are and, as a consequence, how little we tap into our brain's ability to make new associations.

Now, routines are not necessarily bad. People created routines because until recent times, the

world was unpredictable, and just finding food and shelter was filled with risk and danger. Once reliable sources of food, water, and shelter were discovered, it made sense to continue in the same patterns that allowed them to be obtained with a minimum of risk. Discovering and practicing successful routines in an unpredictable world ensured survival.

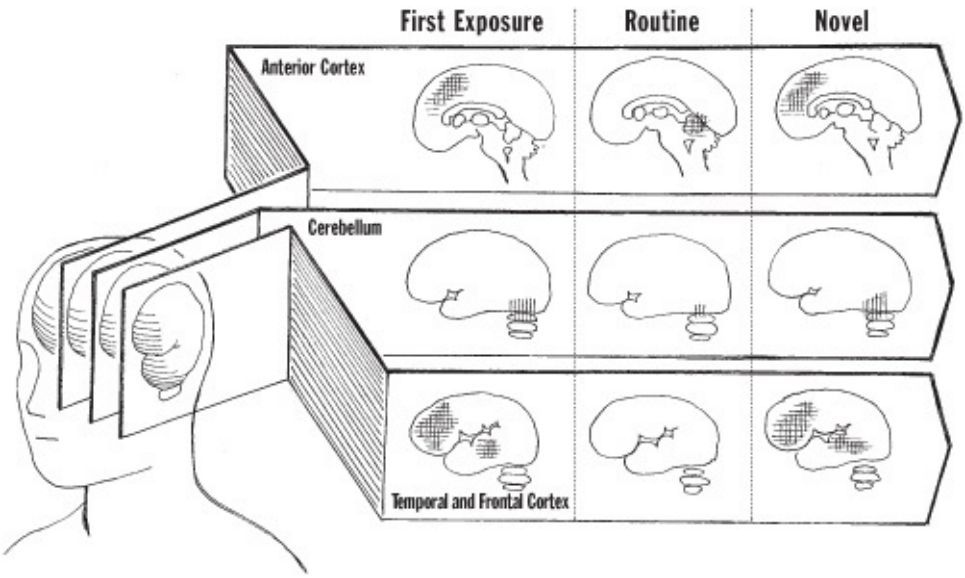
But in our late-twentieth-century, middle-class American lives, such unpredictability is largely gone. Food is readily available at the local supermarket; water flows from the tap; weather-resistant, heated and cooled houses shrug off the climate. Modern medicines ward off most common diseases. We even count on the fact that our favorite TV shows air each week at the same time.[2]

What consequences does this predictability have on the brain? Because routine behaviors are almost subconscious, they are carried out using a minimum of brain energy—and provide little brain exercise. The power of the cortex to form new associations is vastly underutilized.

If you drive or walk to work via the same route every day, you use the same brain pathways. The neural links between brain areas required to perform that trip become strong. But other links to areas that were initially activated when the route was novel—such as a new smell, sight, or sound when yo rounded a certain corner—get weaker as the trip becomes routine. So you become very efficient at getting from point A to point B, but at a cost to the brain. You lose out on opportunities for novelty and the kind of diverse, multisensory associations that give the brain a good workout.

THE BRAIN HUNGERS FOR NOVELTY

The human brain is evolutionarily primed to seek out and respond to what is unexpected or novel—new information coming in from the outside world that is different from what it expects. It's what turns the brain on. In response to novelty, cortical activity is increased in more and varied brain areas.[3] This strengthens synaptic connections, links different areas together in new patterns, and pumps up production of neurotrophins.



PET scans of three vertical slices of the brain show that significantly more pathways are activated (shown in cross-hatching) when the brain processes a Novel task than when it perform a Routine one. During the routine task (middle column) there is no increased activity in the anterior cortex, cerebellum, or frontal cortex.

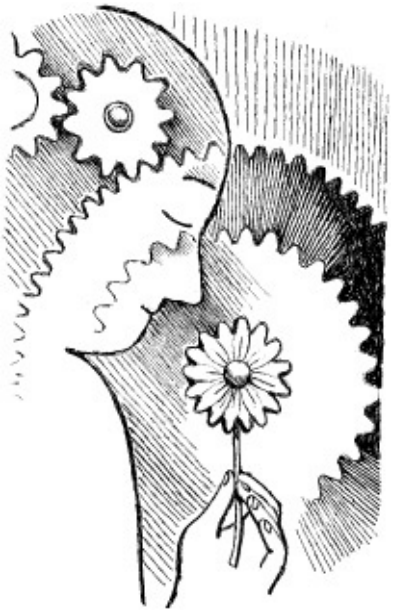
But if it is simply *more* activity in the brain that leads to increased neurotrophin production, then listening to more music (even noise), or watching more TV, or getting a massage—all of which stimulate the sense organs—would lead to better brain health. Such passive stimulation of the senses however, doesn't work as a brain exercise and neither does repeatedly doing the same routine activities. Neurobics is neither passive nor routine. It uses the senses in novel ways to break out of everyday routines.

OUR UNDERUSED SENSES

Our five senses are the portals, or gateways, through which the brain gets its entire contact with the outside world. We rely primarily on our senses of vision and hearing because they quickly tell us a lo about our environment. Our other senses—smell, taste, and touch—are less frequently and obviously called upon. To understand this better, close your eyes and try walking through a room. Instantly, the world around you changes radically. Sounds, smells, and spatial memories of your physical surroundings leap into consciousness. With vision gone, your sense of touch suddenly becomes paramount. Navigating even a familiar environment is a real challenge, and your brain goes into high alert.

The brain has a huge network of pathways based on visual information. That's why so many everyday experiences are geared to visual appeal. In magazine, television, and billboard ads, businesses use visual associations to encourage purchasing decisions. In a world increasingly dominated by shrink-wrapped, plastic-packaged, and deodorized items, the efforts demanded of our other senses, such as touch and smell, are diminished—far more than we're consciously aware of.

Information and associations based on smell used to be far more relevant than they are today. A keen sense of smell was often vital to survival. Native Americans could track animals by their smell; farmers could smell when a change in the weather was about to happen; smell was important in making sure that foods were safe to eat; doctors even used their sense of smell to diagnose illness. Today, unless you have a very special job, such as creating perfumes, aromas usually function as masks (that's why we use deodorants and fragrances).



Despite its diminished role in our daily lives, however, the sense of smell plays an important role in memory. Associations based on odors form rapidly and persist for a very long time, unlike those

based on the other senses. The olfactory system is the only sense that has direct connections to the cortex, hippocampus, and other parts of the limbic system involved in processing emotions and storing memories (see illustration, *The Limbic System*). That's why certain aromas like fresh-baked bread or a particular flower, spice, or perfume can trigger an abundance of emotional responses that stimulate the memory of events associated with them. (For example, realtors often advise you to hav something delicious baking in the oven when you're showing your house for sale. And if you saw *Scent of a Woman*, you'll remember how Al Pacino's blind character could call up complex associations based on smell alone.)

WHAT ABOUT "SMART DRUGS" AND DIETS?

Progress in neuroscience research has also led to promising drugs for treating serious brain ailments like Alzheimer's and Parkinson's diseases. But an unfortunate by-product of this progress in a society oriented to a "pill for every ill" is a growing demand for medications, pills, or diet supplements that will either magically halt declines in mental abilities or improve performance with a quick fix.

The media perennially tout the promise of new memory-enhancing pills with advertisements for "smart drugs." There are, in fact, drugs that do increase the synaptic transmission in the brain in various ways, and some of these may provide short-term memory enhancements. The problem is that there are always hidden and still unknown risks in using such drugs. (Remember the negative side effects on athletes who took steroids to boost physical performance?) Furthermore, the effects of "smart drugs" are only short term, so they have to be taken continuously.

If, magically, there were a drug to increase mental performance, it would do no good unless you were exercising the brain at the same time. It would be like drinking one of those high-protein boosters and then not doing any physical exercise.

There are also claims that brain performance can be enhanced or preserved by taking large amounts of certain naturally occurring vitamins, minerals, or plant extracts. While there is no question that a well-balanced diet and physical exercise are important for maintaining a healthy brain, there is no clear scientific evidence to support the claimed memory benefits of specific dietary supplements.

We believe a more prudent route to brain health is to harness the brain's ability to manufacture its own natural nutrients. With this approach, neurotrophins and similar molecules will be produced in the right places, and in the right amounts, without side effects.

THE SIXTH SENSE: EMOTION

Researchers are finding that brain circuits for emotions are just as tangible as circuits for the senses, and advanced imaging techniques can now observe this.[4] It is also clear from a number of studies tha one's ability to remember something is largely dependent on its emotional context.[5] As we discussed earlier, the hippocampus is more apt to tag information for long-term memory if it has emotional significance. That's why engaging emotions through social interactions is a key strategy of Neurobic

Interactions with other people are an important trigger of emotional responses. Also, since social situations are generally unpredictable, they are more likely to result in nonroutine activities. Most people have a strong, built-in need for these interactions, and in their absence, mental performance

declines. As we age, our social circles tend to shrink, so an important aspect of Neurobic exercise is t find opportunities to interact with others. Not only does this engage our interest, which directly helps us to remember things, but as the MacArthur Foundation's studies on aging have clearly demonstrated, social interactions themselves have positive effects on overall brain health.[6]

The pace and structure of modern life has reduced the number and intensity of our ordinary, day-to-day social interactions, just as modern conveniences have deprived us of the richness of many sensory stimulations. Remember when buying gas meant talking with an attendant instead of swiping a card at a gas pump? Or getting cash involved dealing with a bank teller instead of pushing buttons o an ATM machine? Or a night out involved going to the movies with a crowd rather than renting a video and sitting alone in front of your VCR? And the computer and the Internet have isolated us eve further from any number of personal transactions.

There's ample evidence today that being out in the real world, where you're engaging all the senses, including the important emotional and social "senses," is essential to a healthy brain and an active memory—especially as you age.

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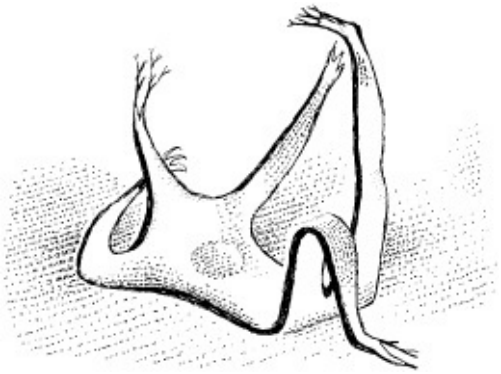
The aim of Neurobics and the exercises that follow is to provide you with a balanced, comfortable, and enjoyable way to stimulate your brain.

As we have shown, Neurobics is a scientifically based program that helps you modify your behavior by introducing the unexpected to your brain and enlisting the aid of *all* your senses as you g through your day. An active brain is a healthy brain, while inaction leads to reduced brain fitness. Or in simpler words—"Use it or lose it."

Chapter III

How Neurobics Works

There is nothing magic about Neurobics. The magic lies in the brain's remarkable ability to convert certain kinds of mental activity into self-help. Happily for everyone with busy lives, there is no need to find a special time or place to do Neurobic exercises. Everyday life is the Neurobic Brain Gym. Neurobics requires you to do two simple things you may have neglected in your lifestyle: Experience the unexpected and enlist the aid of *all* your senses in the course of the day.



No exercise program is going to help if you aren't motivated and can't find time to do it. That's why Neurobic exercises are designed to fit into what you do on an ordinary day—getting up, commuting, working, shopping, eating, or relaxing. Just as weight-loss experts advise against fad die in favor of changing your overall eating habits, Neurobics is recommended as a *lifestyle* choice, not a crash course or a quick fix. Simply by making small changes in your daily habits, you can turn everyday routines into "mind-building" exercises. It's like improving your physical state by using th stairs instead of the elevator or walking to the store instead of driving. Neurobics won't give you bac the brain of a twenty-year-old, but it can help you to access the vault of memories and experience tha a twenty-year-old simply doesn't own. And it can help you keep your brain alive, stronger, and in better shape as you grow older.

Many Neurobic exercises challenge the brain by reducing its reliance on sight and hearing and encouraging the less frequently used senses of smell, touch, and taste to play a more prominent role i everyday activities. By doing so, rarely activated pathways in your brain's associative network are stimulated, increasing your range of mental flexibility.

WHAT MAKES AN EXERCISE NEUROBIC?

Throughout the course of every day, your brain is activated by your senses, and you encounter new stimuli all the time. Why aren't these Neurobic activities? What is it about the specific things we suggest that make them Neurobic?

To begin with, not everything that's novel provides the kind of nerve cell stimulation necessary to activate new brain circuits and enhance neurotrophin production. For example, if you normally write with a pen and one day choose to write everything in pencil, you've broken your routine and are doin something new. But such a small change wouldn't register as an important new sensory association.

would not be enough to engage the circuitry required to really give your brain a workout.

Contrast this with deciding one day to change the hand you normally write with. If you are right-handed, controlling a pen is normally the responsibility of the cortex on the left side of your brain. When you change to writing left-handed, the large network of connections, circuits, and brain areas involved in writing with your left hand, which are normally rarely used, are now activated on the righ side of your brain. Suddenly your brain is confronted with a new task that's engaging, challenging, ar potentially frustrating.

So, what are the conditions that make an exercise Neurobic? It should do *one or more* of the following:

1. **Involve one or more of your senses in a novel context.** By blunting the sense you normally use, force yourself to rely on other senses to do an ordinary task. For instance:

   Get dressed for work with your eyes closed. Eat a meal with your family in silence.

   Or combine two or more senses in unexpected ways:

   Listen to a specific piece of music while smelling a particular aroma.

2. **Engage your attention.** To stand out from the background of everyday events and make your brai go into alert mode, an activity has to be unusual, fun, surprising, engage your emotions, or have meaning for you.

   Turn the pictures on your desktop upside down. Take your child, spouse, or parent to your office f the day.

3. **Break a routine activity in an unexpected, nontrivial way.** (Novelty just for its own sake is not highly Neurobic.)

   Take a completely new route to work. Shop at a farmers market instead of a supermarket.

WHAT HAPPENS IN THE BRAIN WITH NEUROBICS

Let's look again at the example under *From Theory to Practice* of Jane returning home from work an entering her apartment, but now let's consider what is actually happening in her brain that makes the few minutes of her day a Neurobic exercise.

Jane reached into her pocketbook and fished inside for the keys to her apartment. Usually they were the outside flap but not today. "Did I forget them?! No…here they are." She felt their shapes to figur out which one would open the top lock.

Jane’s keys are in the depths of her handbag, which is filled with dozens of different objects—eyeglass case, lipstick, tissues—each with a different texture and shape. Instead of using vision to quickly find the keys, as she might routinely do, she relies now on her sense of *touch.*

Because getting into her apartment is important to her, her brain’s attentional and emotional circuits are active as she touches the hard, smooth exterior of her lipstick case, moves past the soft feel of tissues, and eventually identifies the keys. In her brain, long-dormant associations are being reactivated between the areas of her cortex that process touch, areas in the visual part of her cortex that hold the mental “pictures” of objects, and areas of the brain that store the names of objects.

This reactivation causes specific groups of nerve cells to become more active in an unusual patter for Jane. This in turn can activate the cells’ neurotrophin production and strengthen or build another set of connections in her brain’s “safety net.”

It took her two tries until she heard the welcome click of the lock opening.

Normally, placing a key in a lock uses vision and “motor memory”—an unconscious “map” in the parts of our brain that control movement—which provides an ongoing feedback that allows us to sens where parts of our body are in space. (This is called the proprioceptive sense.) But this time Jane is trying to fit a key into a lock by using the motor map in conjunction with her tactile, not visual, sense And this nonroutine action is activating and reactivating seldom-used nerve connections between her sense of touch and her proprioceptive sense.

Touching the wall lightly with her fingertips, she moved to the closet on the right, found it, and hung up her coat. She turned slowly and visualized in her mind the location of the table holding her telephone and answering machine

On most days, and in most situations, Jane, like the rest of us, makes her way through the world using sight as a guide. Over time, her visual system has constructed a spatial “map” of her apartment in various parts of the brain. Her other senses of touch and hearing have also been tied into these maps, but these nonvisual connections are rarely called upon. Today, however, Jane is using her sens of touch to trigger a spatial memory of the room in order to navigate through it. The touch pathways

that access her spatial maps, usually dormant, are now critically important for accomplishing this simple task and unexpectedly get exercised. And the same holds true for her other senses.

Carefully she headed in that direction, guided by the feel of the leather armchair and the scent of a vase of birthday roses, anxious to avoid the sharp edge of the coffee table and hoping to have some messages from her family waiting.

Here, Jane's olfactory system is kicking into high gear to do something it rarely does—help her smell her way through the world. The olfactory system has a direct line into the hippocampus, the are of the brain that constructs spatial maps of the world. The odor of the roses is working at several brai levels. The emotional association of roses with her birthday, combined with an important emotional goal of getting to her answering machine and retrieving messages from her family, makes them a strong, meaningful stimulus. In addition, Jane is constructing a powerful new association— not only are flowers something that smell good and make you feel good, but they can show you where you are in part of your world.

Today was different…

Yes, it was. By spending just a few minutes doing all the things she normally would do when coming home in a novel way, Jane had engaged literally dozens of new or rarely used brain pathways Synapses between nerve cells were strengthened by these unusual and challenging activities. And in response to their enhanced activity, some of Jane's brain cells were beginning to produce more brain growth molecules, such as neurotrophins.

Furthermore, as a result of the exercise, a small but significant change has occurred in Jane's brain. New sensory associations, such as the *feel* of the leather armchair, had become part of her brain's vocabulary when she entered the room the next day.

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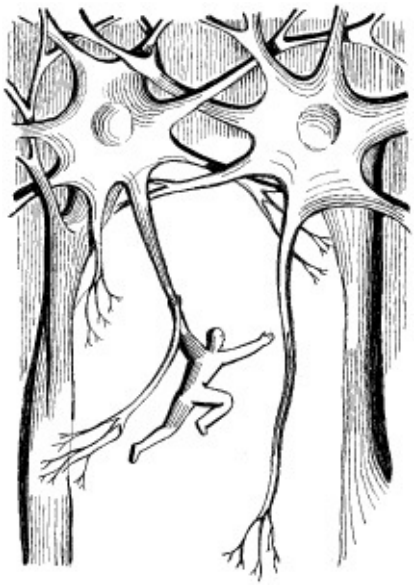
HOW TO USE THIS BOOK



Like the body, the brain needs a balance of activities. Fortunately, the ordinary routines present hundreds of opportunities to activate your senses in extraordinary ways. To demonstrate how to