

## *What Influences your Mind-Body Connection ?*

Everyone is unique and this uniqueness must be understood and treated with a strategy that will enhance one's ability to **take control** of his/her life. The brain function depends on internal and external communication: the receipt, transmission, storage, and interpretation of information (sounds, odors, feelings, visions and taste). It receives messages from several sources, each dealing with separate types of information. Input dealing with everyday matters such as news, music, jobs, relationships, weather etc., comes from the external environment. Our own bodies provide data concerning movement, digestion, tension, pain and even our own thoughts, all in the form of message units sent to the brain.

Considering everything the brain does, how can this relatively small mass of tissue possibly be the source of our personalities, dreams, thoughts, sensations, utterances, and movements? The brain, nervous system, and muscles are obeying servants of information placed in the brain. But the ability of your body and brain to manifest the desired self-image depends upon its indelibility. It must be *tattooed* on the brain. With such a strong image of ourselves and the desired behavioral patterns, it would be difficult not to live out and manifest all our objectives. Instead of just 'having goals', we *become* them.

**Understanding the Brain:** If you know what to look for, you can observe specific aspects of your own brain in action:

**Vision:** The "now you see it, now you don't" feeling you get when you see an illusion is your brain trying to interpret raw data from the eyes. Far from taking a picture of the world and sending it to the brain, the eyes actually transmit very little information; "seeing" is a creation of the brain, on one hand it recognizes motion and on the other hand it identifies – that's where our experiences and beliefs come into play.

**Thought:** Sometimes, you can have trouble thinking after taking an antihistamine. This is because antihistamines do not just combat the effects of an allergy; they also block histamine as a neurotransmitter in the brain, altering your ability to think, and process information. Once again, your thoughts are a product of your experiences and beliefs.

**Motor skills:** When you learn how to walk, ride a bicycle, knit, dance, or perform some other motor skill, you reach a point where all of a sudden you are able to coordinate the new movement. That is because specialized neurons in your brain's cerebellum are now firing in sequence.

**Emotion and memory:** Think about doing your taxes. Does that thought elicit a particular emotion, maybe a headache as well? We do not just remember something; our memories are colored with emotion. All of our experiences are influenced by previous experiences through complex loops in the brain's limbic system. However, what you previously believed may not be the same as you believe today.... Ask why??

**Social bonding:** Your feeling of well-being with your spouse or friends has a neuro-chemical basis. The neurotransmitter oxytocin is found in very high concentrations in the limbic systems of animals that bond socially. How we use our verbal and body language is extremely important when considering the law of attraction and Neuro-Linguistic Programming.

**Consciousness:** Sometimes, you can arrive at work with very little memory of the details of your journey; obviously you were not unconscious, but you were not fully aware either. This occurs when your brain is in "autopilot" mode—where it was in control without your being conscious of all that was happening around you (this is a form of hypnosis, a trance state at which time the sub-consciousness mind is the center of focus).

Everything that goes on inside your body and every interaction you have with the outside world involves feedback and interpretative processes which depend on the brain for internal and external action. It allows you to cope masterfully with your everyday environment. It is capable of producing breathtaking athletic feats, sublime works of art, and profound scientific insights. It also produces the enormous range of emotional responses that can take us from the depths of depression to the heights of euphoria.

**Human Enrichment Advisors evaluates all sensory functions as a part of its therapeutic process.**

### **Solving the Mystery of the Brain**

The brain is still a mystery in many respects—for example, we still are unsure as to how consciousness is generated—but recent decades have seen unparalleled advances in understanding how the brain does what it does. In the last 50 years, an explosion of knowledge about the brain's structure and function has occurred. Scientists have performed amazing research by using tools such as MRIs and PET scanning to get a better grasp on deciphering the mysteries of how this important organ works.

Due to these technological advances, a relatively recent (the early 1990s) discovery was made that documents the way the brain is able to build new pathways, essentially remapping itself, enabling the growth of new neurons, expanding functions including memory, cognitive and motor skills. This recent neuroscience field is referred to as **neuro-plasticity** – the plastic brain & its ever changing qualities.

**Higher-Order Cognitive Functions:** Areas of the brain thought to be responsible for language, emotion, executive function, and cognition—abilities that, in large part, define us as humans. You look at the underlying neurological mechanisms and explore their role in various phenomena like depression, musical ability and appreciation, and drug use.

**Special Topics:** Are the brains of males and females different? As we age, how are our senses affected and how do we act differently? How does the brain regulate sleep and

dreaming? What is consciousness? And how can you understand the signs and symptoms of Alzheimer's disease?

Our insights into the functioning of the brain often come from cases where something has gone wrong, such as strokes, tumors, injuries, neurological diseases, and mental illnesses—pathologies that vividly demonstrate the distinct roles played by the various affected regions.

## How can my emotions affect my health?

Your body responds to the way you think, feel and act. This is often called the “**mind/body connection**.” When you are stressed, anxious or upset, your body tries to tell you that something isn't right. For example, high blood pressure or a stomach ulcer might develop after a particularly stressful event, such as the death of a loved one. The following can be physical signs that your emotional health is out of balance:

- Back pain
- Change in appetite
- Chest pain
- Constipation or diarrhea
- Dry mouth
- Extreme tiredness
- General aches and pains
- Headaches
- High blood pressure
- Insomnia (trouble sleeping)
- Lightheadedness
- Palpitations (the feeling that your heart is racing)
- Sexual problems
- Shortness of breath
- Stiff neck
- Sweating
- Upset stomach
- Weight gain or loss

Poor emotional health can weaken your body's immune system, making you more likely to get colds and other infections during emotionally difficult times. Also, when you are feeling stressed, anxious or upset, you may not take care of your health as well as you should. You may not feel like exercising, eating nutritious foods or taking medicine that your doctor prescribes. Abuse of alcohol, tobacco or other drugs may also be a sign of poor emotional health.

## Why does my coach-advisor-doctor need to know about my emotions?

You may not be used to talking to your doctor about your feelings or problems in your personal life. But remember, he or she can't always tell that you're feeling stressed, anxious or upset just by looking at you. It's important to be honest with your doctor if you are having these feelings.

First, he or she will need to make sure that other health problems aren't causing your physical

symptoms. If your symptoms aren't caused by other health problems, you and your doctor can address the emotional causes of your symptoms. Your doctor may suggest ways to treat your physical symptoms while you work together to improve your emotional health.

If your negative feelings don't go away and are so strong that they keep you from enjoying life, it's especially important for you to talk to your specialist.

## **How can I improve my emotional health?**

The following are similar steps taken by Human Enrichment Advisors' in the evaluation and coaching process.

First, try to recognize your emotions and understand why you are having them. Sorting out the causes of sadness, stress and anxiety in your life can help you manage your emotional health. The following are some other helpful tips.

**Express your feelings in appropriate ways.** If feelings of stress, sadness or anxiety are causing physical problems, keeping these feelings inside can make you feel worse. It's OK to let your loved ones know when something is bothering you. However, keep in mind that your family and friends may not be able to help you deal with your feelings appropriately. At these times, ask someone outside the situation--such as your family doctor, a counselor or a religious advisor--for advice and support to help you improve your emotional health.

**Live a balanced life.** Try not to obsess about the problems at work, school or home that lead to negative feelings. This doesn't mean you have to pretend to be happy when you feel stressed, anxious or upset. It's important to deal with these negative feelings, but try to focus on the positive things in your life too. You may want to use a journal to keep track of things that make you feel happy or peaceful. Some research has shown that having a positive outlook can improve your quality of life and give your health a boost. You may also need to find ways to let go of some things in your life that make you feel stressed and overwhelmed. Make time for things you enjoy.

**Develop resilience.** People with resilience are able to cope with stress in a healthy way. Resilience can be learned and strengthened with different strategies. These include having social support, keeping a positive view of yourself, accepting change, and keeping things in perspective.

**Calm your mind and body.** Relaxation methods, such as meditation, are useful ways to bring your emotions into balance. Meditation is a form of guided thought. It can take many forms. For example, you may do it by exercising, stretching or breathing deeply. Ask your family doctor for advice about relaxation methods.

**Take care of yourself.** To have good emotional health, it's important to take care of your body by having a regular routine for eating healthy meals, getting enough sleep and exercising to

relieve pent-up tension. Avoid overeating and don't abuse drugs or alcohol. Using drugs or alcohol just causes other problems, such as family and health problems.

At the turn of the 20th century, the leading causes of death after cardiovascular diseases were infectious germs (e.g., influenza, pneumonia, tuberculosis, gastritis, colitis, diphtheria, typhoid). **Now in the 21st century, the most reliably fatal conditions are strongly affected by lifestyle.** Cardiovascular diseases (like heart disease or stroke) still top the list. These are followed closely by: malignant neoplasms (tumors that can be triggered by environmental exposures and accelerated by neglect of emotional responses), accidents, chronic obstructive pulmonary diseases (often resulting from smoking), influenza and pneumonia, diabetes mellitus (for those afflicted, the self-management of behavior strongly affects the course of the disease), suicide, chronic liver diseases and cirrhosis (often following drug and alcohol abuse).

Risk factors that most of us encounter in everyday life include: crowding, pollution, noise, sleep deprivation, and various environmental exposures. Additional risks for many segments of our population involve: social isolation, limited education, inadequate or unbalanced diet, hazardous occupations, financial stressors, substance abuse, unsafe sexual practices, lack of exercise, obesity, and poor health care. In recognition of the strong behavioral components affecting major diseases, a growing knowledge about behavior change, and the possibilities offered by biofeedback behavioral medicine was established at a 1977 conference.

The more recent evolution of psycho physiological and behavioral medicine is called health psychology. This specialty within psychology identifies the correlates of health, diagnoses and treats certain chronic diseases, prevents illness, and modifies behavioral factors involved in physiological and psychological rehabilitation (e.g., **lowering hypertension, controlling serum cholesterol levels, managing stress, alleviating pain, reduction of cigarette smoking and alcohol use, diet, and exercise**). There is also a growing body of interdisciplinary research called psychoneuroimmunology (wherein psychological variables are known to directly change nerves and the body's immune system response to physical threats).

Strictly biomedical explanations ignore the context of neurophysiologic events. These physically measurable phenomena are adaptively linked to environmental changes and demands. Computer malfunctions don't only follow breakdowns in the machinery (i.e., hardware). A more common complaint is that flaws ("bugs") in the instructions (i.e., software) derail required operations. Psychology takes human "software" into account. Causal pathways (which "hardware" components the "software" controls) established in mind/body medicine include: the nervous system, the endocrine system, the immune system, the musculo-skeletal system, health-related behaviors, and the effects of social support.

**Aristotle once wrote: "Soul and body, I suggest, react sympathetically upon each other." Now, millennia later, we know how and why.**

### **Stress – a Real KILLER**

UCLA scientists found that the stress hormone cortisol suppresses immune cells' ability to activate their telomerase. This may explain why the cells of persons under chronic stress have shorter telomeres.

The study reveals how stress makes people more susceptible to illness. The findings also suggest a potential drug target for preventing damage to the immune systems of persons who are under long-term stress, such as caregivers to chronically ill family members, as well as astronauts, soldiers, air traffic controllers and people who drive long daily commutes.

### **Psychoneuroimmunology**

Psychoneuroimmunology is the name for the study of the mind-body connection, or PNI for short. PNI has been around for the last 20 years or so and has revolutionized the way we look at health and wellness. There was a point in human existence when the connection between the mind and the body was taken for granted. A couple of centuries ago, science had grown to understand the "mechanical universe" concept. The laws of Sir Newton and the science of physics had begun to infiltrate the science of medicine. If the universe followed mechanical laws, so might the body. To prove this theory, scientists needed to open a body up to observe how it worked. The Church was very adamant about the body being the temple of the soul and could never be desecrated. After much haggling and several smoke-filled back room discussions, an agreement was reached. The Church would maintain its jurisdiction over "the mind" for that is where the personality and soul "truly" resides and science could have the body, which is just a "machine for the mind" and upon death, would become simply an empty vessel.

### **Placebo Effect**

Furthering the rift, more recent science has discovered that specific diseases can be "cured" through specific medicinal formulas or drugs. This "magic bullet" mentality spread throughout medicine and science. Truly the body was a mechanical thing that responded to specific stimulus and could be counted on to respond the same way every time. Wonderful news, the body did not respond as intended. Science has tried to brush aside or explain away this phenomenon by saying, "Oh, it's just the placebo effect" or "It's spontaneous remission" as well as other innocuous terms seemingly to lessen its importance. It is human nature when something is not understood to dismiss it, diminish it or ignore it all together. This search to seek out answers to this reoccurring phenomenon is the basis for PNI, the way the mind-body connection is made and how we can utilize it for greater health and well-being.

### **Over the past decade, we have come a long way in understanding the psycho-biology of mind-body communication and the mental/emotional processes involved.**

To begin with, most of us have a basic understanding of how psycho-biology communication occurs through the nervous system. Messages are transmitted through electrical impulses along a system of nerves that connect the brain to every system, organ, gland, muscle, etc. When we want to lift our arm, the specific signals race along the nerves to the required muscles, ligaments, etc., in order to accomplish the task. There is, also, the "autonomic" nervous system that sends the electrical impulses automatically, without conscious thought, to such parts as the heart, lungs, digestive tract, etc.. That way we don't have to worry about things like forgetting to have our heart beat.

## **Autonomic Immune System**

There is another facet to this seemingly automatic activity, the "autonomic immune system". The immune system cells, which free-float throughout our bodies, act all on their own, automatically. When you get an infection, the immune system kicks in and takes care of the problem. How do they know when to go into action? New research is pointing that there is another open line of communication. A biochemical, molecular code that is transmitted to each cell. This code is in the form of hormones or neuroceptides. Each cell of the body has receptors for these neuroceptides. The code contained in the peptide is then communicated to the cell. The cell then acts according to this communication, just like a muscle acts according to the signals it receives. The cell then sends biochemical responses back into the system. This allows for the two-way communication not only between itself and the brain, but also between itself and other cells. This shows itself openly the well coordinated immune cells attacking invading bacteria. Communication is paramount to a successful immune system defense.

## **Limbic-Hypothalamic System**

This biochemical connection must also have a direct link to the mind. Researchers have found that link. If you were to draw a line through your head starting just behind your ear going to just behind the other ear, at the middle of that line you would find a clumping of glands and blood vessels called the Limbic-Hypothalamic System which consists of the limbic system, hypothalamus and the pituitary gland. The connection works this way. A mental/emotional state exists within the mind; the mind transmits the image of that state through the nervous system and to the Limbic-Hypothalamic system. Every system, organ, gland, fiber and cell of the body receives the message. Then they each act according to the message. To illustrate a point, a university study was done on the immune system of persons whose long-term partner had recently died. Having factored out all other affecting stimulus but grief, it was discovered that the immune system in the state of deep grief operated at 70% decrease of activity. In other words, the immune system was running at only 30%. That can explain why the widowed spouse, who was never sick in their life, would die of pneumonia or such related disease, 6 months after their spouse's death.

## **Positive - NOT Negative Thoughts**

You know yourself, how emotions can boost your energy level or drain it to almost nothing. The images and experiences that we fill our mind with get communicated and then translated physically. This is how stress operates. The major stressors (like job loss, death, divorce and etc.) while having a significant effect, are not the major culprit of stress related health problems. It seems that the little stressors (like being late for work, a car cutting you off on the expressway, etc.) have more effect on us physically. The theory is that the little stressors are judged to be of little or no importance, so we tend to ignore their effect. All those little frustrations, unconsciously remain frustrations even when they are forgotten long ago to our conscious awareness. They

linger on and their effects never diminish.

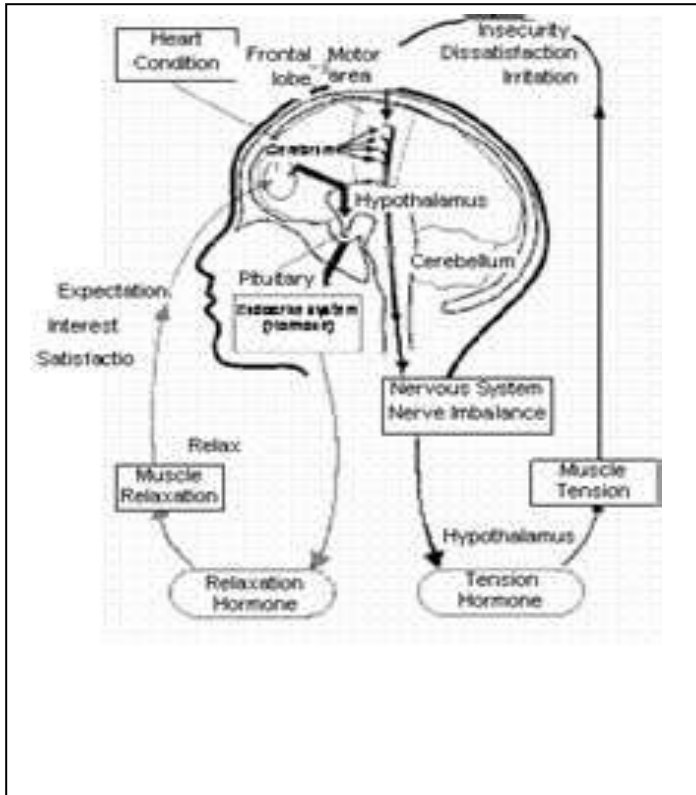
All the images we carry with us are communicated to all parts of our body all the time. You tell yourself something often enough, you will start believing it. The body hears that you "don't have a leg to stand on" or you're dying of cancer", or that argument you had with your parents twenty years ago is still eating away at you. It will then respond to that communication. If you have an internal image of "I only seem to take time off when I'm sick", your body will make you sick when you need that time off. You can be sure your body will give you what you expect. Think negative and bad things can happen; think positive and good things can happen. It's all within the mind and body connection.

Now we understand the communication between the mind and body, let's go back to how the mind can assist the body in healing. One method of accomplishing that is through hypnotherapy. Hypnotherapy is the reconditioning of certain sensory reactions to the stimuli of anxiety so that physiological symptoms such as ulcers and headaches will not be produced. Habitual reactions of the patient are altered under hypnosis. After the therapist has changed the patient's anxiety-producing sensation system, the subject is trained in the use of the new responses in life outside therapy.

## *Your Cognitive Function*

You have probably heard about cognitive function or cognition. What is cognition? Cognition has to do with how a person understands and acts in the world. It is a set of processes that are part of nearly every human action. Cognitive abilities are the brain-based skills we need to carry out any task – from the simplest to the most complex. They have more to do with the mechanisms of how we learn, remember, problem-solve, and pay attention rather than with any actual knowledge. Any task can be broken down into the different cognitive skills or functions needed to complete that task successfully.

The fields of neuropsychology, cognitive psychology, and thus cognitive training are based on the framework that cognition consists of different mental functions which are based on specific constellations of brain structures. The table below identifies the main brain functions involved in cognition



Brain Function	Skills involved
Perception	Recognition and interpretation of sensory stimuli.
Attention	<ul style="list-style-type: none"> <li>Ability to sustain concentration on a particular object, action, or thought.</li> <li>Ability to manage competing demands in our environment.</li> </ul>
Memory	<ul style="list-style-type: none"> <li>Short-term memory (limited storage).</li> <li>Long-term memory (unlimited storage).</li> </ul>
Motor	<ul style="list-style-type: none"> <li>Ability to mobilize our muscles and bodies.</li> <li>Ability to manipulate objects.</li> </ul>
Language and Auditory Processing	Skills allowing us to differentiate and comprehend sounds and generate verbal output
Visual and Spatial Processing	<ul style="list-style-type: none"> <li>Ability to process incoming visual stimuli.</li> <li>Ability to visualize images and scenarios.</li> </ul>
Executive Functions	<p>Abilities that enable goal-oriented behavior, such as the ability to plan, and execute a goal. These include:</p> <ol style="list-style-type: none"> <li><b>Flexibility:</b> the capacity for quickly switching to the appropriate mental mode.</li> <li><b>Theory of mind:</b> insight into other people's inner world, their plans, their likes and dislikes.</li> <li><b>Anticipation:</b> prediction based on pattern recognition.</li> <li><b>Problem-solving:</b> defining the problem in the right way to then generate solutions and pick the right one.</li> <li><b>Decision making:</b> the ability to make decisions based on problem-solving, on incomplete information and on emotions</li> </ol>

## The main brain functions involved in cognition

“My brain is...fried, toast, frazzled, and burnt out.” How many times have you said or heard one version or another of these statements. Most of us think we are being figurative when we utter such phrases, but research shows that the biological consequences of sustained high levels of stress may have us being more accurate than we would like to think.

### Crash Course on Stress

Our bodies are a complex balancing act between systems working full time to keep us alive and well. This balancing act is constantly adapting to the myriad of changes occurring every second within ourselves and our environments. When it gets dark our pupils dilate, when we get hot we sweat, when we smell food we salivate, and so forth. This constant balancing act maintains a range of stability in the body via change; and is often referred to as allostasis. Any change which threatens this balance can be referred to as allostatic load or stress.

Allostatic load/stress is part of being alive. For example just by getting up in the morning, we all experience a very important need to increase our heart rate and blood pressure in order to feed our newly elevated brain. Although usually manageable, this is a change which the body needs to adapt to and, by our definition, a stressor.

Stress is only a problem when this allostatic load becomes overload. When change is excessive or our ability to adapt is compromised, things start to go wrong. We will focus here on what seems to be happening in the brain under such conditions.

### Energy Mobilization

Whether it's getting up in the morning, worrying about the non-existent past/future, or getting angry at your last parking ticket, stress takes energy. One of the major roles of the infamous fight or flight response is to mobilize energy, and it does this well. If you need to run away from a swarm of killer bees or fend off an attacking bear, you will be assisted by various chemicals produced within the body. These include the well-known adrenaline—now more commonly referred to as epinephrine—and a lesser known group of chemicals known as the glucocorticoids, most notably cortisol. Both epinephrine and the glucocorticoids are involved in making stored energy available for use in the form of fats and sugars. Epinephrine does so over the short term (within seconds) while glucocorticoids act over a longer period (minutes to hours). Let's look at the effects of the later of the two, the glucocorticoids.

(ours and others’).

6. **Working Memory:** the capacity to hold and manipulate information “on-line” in real time.
7. **Emotional self-regulation:** the ability to identify and manage one’s own emotions for good performance.
8. **Sequencing:** the ability to break down complex actions into manageable units and prioritize them in the right order.
9. **Inhibition:** the ability to withstand distraction, and internal urges.

## **Your Brain on Stress**

Cortisol, the most prominent of the glucocorticoids, does an excellent job of allowing us to adapt to most stressors which last more than a couple of minutes but under an hour. Short term it will actually enhance our immune system, memory and attention. Long term, past  $\hat{A}$ ½ hour to an hour, excessively elevated cortisol levels start to have detrimental effects. It seems we were designed more to deal with short spurts of high stress, such as beating back that attacking bear, rather than long drawn-out stressors...such as meeting deadlines.

Our brains appear to be most vulnerable to the effects of excessive stress in a region called the hippocampus. The hippocampus is a mass of neurons each with multiple branch-like extensions (dendrites and axons) which make connections (synapses) with other neurons all across the brain. Among other things, this region is important in dealing with emotions and consolidating new memories. As with all brain regions, its ability to adapt relies upon being able to alter the branching and connections of its neurons. The hippocampus is also one of the only regions of the brain known to be able to produce new neurons, a process called neurogenesis.

## **Brain Damage**

Enduring a high stressor for more than 30 minutes to an hour has been shown to negatively impact the hippocampus in various ways. To begin, sustained exposure to higher than normal levels of cortisol result in the pruning back of the number of branches and synaptic connections of hippocampal neurons. By a variety of mechanisms, these conditions also increase the rate of cell death in this region of the brain.

As if this wasn't bad enough, recent research is also demonstrating that sustained increases in glucocorticoid levels also has negative effects, impairing the hippocampus's ability to create new neurons.

Over a period of time, all of this results in the shrinking in size of the hippocampus with associated declines in cognitive function, including the ability to retain new information and adapt to novel situations.

## **Damage Control**

Fortunately the negative effects of excessive stress can not only be stopped but also reversed once the source (psychological or physical) is removed or sufficiently reduced. Next time we will explore techniques one can use to protect our brains by managing the unavoidable stressors we all face as part of being human.

## **Brain Evolution and Why it is Meaningful Today to Improve Our Brain Health**

You may feel overwhelmed by the stream of seemingly contradictory suggestions regarding the best way to maintain mental clarity as you age. Based on an analysis of seminal factors in the development of modern brain anatomy, I believe it is possible to make some very compelling recommendations for growing big brains, enhancing their function, and making them resistant to the aging process. These may be loosely categorized as factors pertaining to the mental or physical attributes of the brain. Although they are not truly independent entities, such a conceptualization provides a basis for the generation of brain healthy prescriptions. Diet,

physical exercise, and stress reduction enhance neuronal resilience. Sleep and mental stimulation are vital for cognitive ability, learning, and memory.

**Diet:** Follow a modern shore-based/marine diet including seafood in its most general sense, non-starchy vegetables of all colors, berries, and eggs. Other sources of lean protein containing long-chain omega 3 fatty acids such as free range beef, chicken, bison, or elk are nutritious alternatives.

**Physical exercise** (Think ‘fight or flight’ activity.): Include all types. Aerobic activities such as swimming, bicycling, walking, or hiking for promotion of vascular health and weight control; resistance training for promotion of neurotrophic factors, naturally occurring compounds that make brain cells more resistant to aging, such as IGF-1 (Insulin-like growth factor-1) and BDNF (Brain-derived neurotrophic factor); and balance, coordination, and agility training such as ping-pong, balance beam, trampoline, and jumping rope to enhance cognitive speed and motor skills.

**Stress Control:** From an evolutionary perspective, stressors (such as meeting a cave bear) and intense physical activity (running or fighting) were brief in duration and usually occurred together. Modern stressors (psychological or emotional stress) tend to be unremitting and are generally uncoupled from the physical (fight or flight) component, meaning stress develops without any associated physical activity. Such intense physical pursuits are now called exercise. Not surprisingly, exercise is a perfect physiologic antidote for stress due to its beneficial impact on cortisol (the ‘stress’ hormone) and blood pressure and should be incorporated into any program of stress reduction.

**Adequate sleep:** The body needs rest, but the brain requires sleep. Acute or chronic sleep deprivation causes devastating short and long-term consequences to brain anatomy (synaptic loss) and function (memory and learning difficulties). Off-line information processing and memory consolidation are additional sleep-related benefits.

**Mental stimulation:** Brain-training, a cognitively challenging lifestyle, novelty, and socialization are vital for the promotion of neuronal plasticity and neurogenesis (the formation of new nerve cells and neuronal connections), the enhancement of specific brain functions such as memory, and the development of cognitive reserve –additional mental processing potential that may be brought online when needed.

The combination of these recommendations, each of which was instrumental in the transformation from primitive to modern nervous systems, provides a template for the most logical approach for enhancing mental function and resisting neurodegeneration as we travel through life.

### **The Evolutionary Rationale**

The human brain clearly has the genetic potential for dramatic expansion. This was illustrated about 1,500,000 years ago. Enlargement from 900 grams to almost 1300 grams required less than a million years to complete – a mere speck on the evolutionary timeline. Why and how it happened are open questions. What remains undisputed are the magnitude of the change and the impact it had on human capabilities. The rapid volumetric explosion primarily involved the

frontal lobe region, a portion of the brain that, until recently, was referred to as the 'silent' brain because of its relative lack of any discernable functionality. The frontal lobes are now viewed as the 'conductor of the orchestra' because they have been recognized as being responsible for articulating the 'big picture' and coordinating other brain regions, as needed, to execute the 'game plan.' The Prefrontal cortex (PFC), the most anterior portion of the frontal cortex, has dense connections with all the other regions it oversees. It is generally considered the most plastic cortical region because its synapses are continually being torn down and reconfigured in response to real-time experiences. Plasticity allows the brain to 'think on its feet.' Expansion of PFC enabled the cognitive preeminence of modern day humans over all non-human primates. The plasticity of the PFC and its massive connectivity with other brain regions rely entirely on the production and maintenance of point-to-point nerve cell connections, or synapses.

In addition to being a thinking machine, the brain is also a flesh and blood organ that must comply with the laws of metabolism and physiology. Insight into both its 'mental' and 'physical' properties is vital for comprehending key aspects of brain health and function. Much has been written about the facilitation of brain growth by cognitively demanding tasks such as tool use and hunting. However, there is a component of circular reasoning in this argument. For it to participate in such mentally demanding endeavors, the brain would have relied on the prior existence of sophisticated neuronal circuitry. I suggest a nutritional basis for the dramatic cerebral expansion, with enhanced functionality (such as development of tool use and hunting strategy) being the natural responses of a larger, more plastic organ to novelty and environmental challenges. The common link between the evolutionary cerebral expansion and modern brain health/function resides in the massive wiring demands inherent in both processes. This marked amplification in neuronal connectivity is made possible by the enhanced production of synaptic membranes (nerve cell membranes in the regions of points of nerve cell contact).

How was it possible to fuel the production of major increases in neuronal number and synaptic density? This required the concordant expression of genetic potential (likely driven, in part, by the provision of an uninterrupted energy supply) and proper nutritional content – meaning high, sustained caloric and nutrient density. Just as a certain level of fat mass is a prerequisite for expansion of the female body to support a successful pregnancy, a persistent supply of nutrient dense calories is essential for brain expansion. In times of frequent starvation, this was a substantial nutritional demand. To fully appreciate how energetically expensive brains are, consider that modern brains comprise about 2.3% of the body mass, yet consume almost one quarter of the available energy. Newborn brains utilize fully 75% of the body's energy!

What type of brain-building diet might have been accessible 1.5 million years ago that didn't require the cognitive demands inherent in hunting? One solution would be a 'shore-based' diet. This means foraging for life forms such as mollusks, crustaceans, eggs, spawning fish, frogs, and contiguous plant life readily available along lake shores or river banks. In a warm climate it would have provided a year-round, high quality diet abundant in calories, fat and protein. It also supplied long-chain omega 3 fatty acids (including DHA), the building blocks of electrically active membranes in neurons and photoreceptor cells.

Big brains must also synthesize abundant cholesterol and other components of nerve cell membranes. This requires a water-soluble source of appropriate building blocks. Ketone bodies

(acetoacetate and  $\hat{\text{P}}^2$ -hydroxybutyrate) generated naturally from partially burned fat were, and continue to be, an ideal energy source for the brain while simultaneously providing key precursors for synthesis of nerve cell membranes and synapses. These facilitated the anatomic expansion of the brain, which provided the additional neuronal circuitry that made the learning of hunting skills a possibility.

Hence, what was compulsory for explosive brain expansion of the species is as vital today for optimal brain function and plasticity. It is the ongoing ability to produce high levels of the most functional sites of nerve cells – the synaptic membranes. Appropriate assemblies of nerve cells, as determined by their connections (synapses), provide the basis for the functional attributes we enjoy today. Stress reduction, mental stimulation and proper sleep enhance their resistance to the aging process.

It should come as no surprise, therefore, that the brain prefers by far the automatic mode to the effortful one whenever possible. This has many obvious advantages, as well as some disadvantages. Chief among them is the danger that the degree of similarity between past experience and the present problem would be sacrificed for reasons of convenience. This can lead to neglect of important situational features that render the old, familiar solution, inadequate.

This preference and reliance on experiential precedents feeds directly into our tendency to develop routines. After doing something a few times the activity, any activity, becomes gradually a routine one, requiring less attention and less effort. There are many things we do well precisely due to their becoming increasingly more automatic in terms of the cognitive work involved. Driving is a particularly familiar example. Safe driving requires on the average two years of driving experience, during which time the brain develops helpful routines to deal with familiar challenges on the road. However, the tendency to develop routines is by no means relevant exclusively to motor activities.

Thus, word recognition in reading becomes automatic and allows us to attend to meaning rather than the process of decoding each word from its constituent letters and syllables. As we gain experience, even highly complex intellectual activities become routine over time.

Routines make things easier, but for that same reason they become less challenging. Thus, as we go about the tasks of living we become more experienced and those very tasks lose their ability to challenge our brains. Moreover, old people have too much experience. They have seen almost everything, heard almost everything and faced most situations in the past. It is for this reason that everyday life experiences cannot ensure brain fitness any more than they can assure physical fitness. The analogy does not stop here and just as we need physical workout we need cognitive workouts as well.

The above analysis points to activities holding the greatest promise of healthy challenge to the brain. Namely, they have to be novel. Reading a new book, visiting new places, trying new foods, learning to play a musical instrument, or best, learning a new language, these are the activities that brain fitness is made of. And on top of it, engage in quality cognitive training exercises that cover the broad spectrum of cognitive skills and maximize the cognitive value per unit of time spent.