THESIS

i Fitness
A workout gym for the brain

BITA SALEHI
MASTER OF ART IN INTERIOR DESIGN

In partial fulfillment of the requirements
For the Degree of Master of Art
Corcoran College of Art and Design
Washington DC
Spring 2009

CORCORAN
GALLERY OF ART • COLLEGE OF ART + DESIGN
WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY Bita Salehi ENTITLED “i Fitness; a workout gym for the brain” BE ACCEPTED AS FULFILLING, IN PART, REQUIREMENTS FOR THE DEGREE OF MASTER OF ART IN INTERIOR DESIGN.

Graduate Thesis Committee:

Bita Salehi

Carissa Gavin

Catherine Armour

Catherine Armour
Thesis Statement

i Fitness

A brain fitness facility designed to develop brain’s executive functions, enhance memory and advance personal performances.
Thesis Abstract

i Fitness

We exercise our body to stay strong, healthy and in shape, so why shouldn't we exercise our brain to stay mentally fit?

It is now possible to locate and observe complex qualities of the brain through scientific research and it is now possible to perform exercises to stimulate the brain for a better and stronger operation of networking between it's tasks, memory, learning, aging and more.

Recently, for the first time, scientists have provided convincing evidence that each of the 100 billion cells in the human brain has the capacity to grow new contact points (synapses) with its neighbors, creating a more complex and richer network of interconnections. The brain's capacity, referred to as brain plasticity, tends to change and improve with learning new things, and new adaptation throughout life. Also, studies have shown that the more learning and activities the brain obtains, the more synapses are born. The more synapses that are born, the more capable and stronger the network the brain will have. Accordingly it is possible to achieve a better brain function. Therefore the idea of "i Fitness" is born.

The brain fitness center is designed to encourage people to improve their memory, stay sharp and focused, and to work and think in a more effective manner. The brain fitness center, named i Fitness, is a workout environment for people who like to achieve more productivity, strength and youth and to become healthier, better problem-solvers and likewise prevent mental diseases such as memory loss and Alzheimer's, which is a concern of about seventy-six million baby boomers and others. In addition, the moral component of the brain fitness center is that this type of exercise will encourage people to improve their behavior and enhance their vision of themselves, our society and our planet.
The brain is much like an intertwined network of connections as Dr. Majid Fotuhi states in my interview with him at Michel Mirowski Neurology Institute. According to Dr. Fotuhi the brain is not exactly discrete, in other words it is not a case where part A does function A, or part B does function B. However, in order to make this gym a more user-friendly fitness facility, the brain functions will be categorized into segments and stations, to allow individuals to encounter and challenge specific areas of their brain as they desire to achieve more development and strength for that part of the brain.

Each of these stations fulfill specific functions of the brain; frontal lobe, temporal lobe, cerebellum, overall brain health, and peace of mind. In addition, some basic but critical information about the brain will be displayed. A more detailed description of these stations follows:

• “About the brain station”, is an informational station that is located at the entrance. A large scale transparent brain anatomy is structured in this station that provides information and is a directory for other stations. The outer layer of it (brain cortex) contains sensors that light up as it is touched to give directions and provide basic information about that part of the brain. This station guides the visitors in deciding what part of their brain they choose to exercise.

• The Frontal lobe, which is the largest and most anterior part of the brain, is associated with the executive functions, problem solving and ability to think. In order to exercise this part of the brain, there are a series of mazes and configured brain teasers.

• The Temporal lobe, at the lower side of the brain, near the ears is involved in speech, language and responsible for short-term memory function. The exercises provided for this station are puzzles and word-finding exercises displayed on wall screens that randomly varies from basic to advance levels.

• The Cerebellum is associated with balance and coordination. Multi balance training tools and equipment are supplied for this area. This station couples physical activity while exercising this brain function.
• The brain health station is one of the core elements of the concept, as this section recognizes the importance of the blood pressure, necessity of physical exercise, diet and stress reduction by exercising the mind and the body together. This section also engages people to practice Yoga and Tai Chi.

• The hydration station is a water and fresh squeezed juice bar.

The mission is to encourage people to take charge of their brain health and wellness, improve personal development and performance, and increase an interest in exercising the brain casually in everyday life. The brain is like a muscle; it needs exercise too!
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Acknowledgements

I feel passionate and inspired by the impact of a new idea, or a creative mind has on the environment and on human’s life. The brain, “the most complex thing we have yet discovered in our universe”, has been an intriguing subject for me to explore for my thesis project. (I am excited and passionate engaging myself to read, learn, write and design about it.)

It was a truly an honor to have the opportunity to meet with Dr. Majid Fotuhi, who assisted me with his great references and guided me with his great knowledge of neuroscience. I thank him for his kind contribution to this project. Dr. Fotuhi is a faculty member in neurology at Harvard Medical School, a neurology consultant at the Alzheimer’s Disease Research Center at Johns Hopkins Hospital and the head of the center for memory and brain health at LifeBridge Health Brain and Spine Institute. He is also the author of two books: “The Memory Cure”, and “Crosswords to Keep Your Brain Young”, which became the primary resource for of this research paper.

I would like to take this opportunity to respectfully thank Ms. Catherine Armour, the chair of the Interior Design program, for all her efforts in developing growth and success for the Interior Design program at the Corcoran, and I appreciate Carissa Gavin for all her guidance in my thesis project.

Also I would like to take this opportunity and thank my advisor Ms. Susan Moran whose professional and kind demeanor made a pleasant experience in administration processes at all time. My special thanks to Ms. Matilda Cox for her critical overseeing and advising throughout the program, to Ms. Maria Morga who shared her proficient and advanced skills graciously at all time, Mr. Charles Mitchell, the master of digital drafting in all means, who shared his knowledge always with full of energy and encouragement, and all other faculty members who brought me closer to my goal of practicing this profession towards a stronger and deeper understanding of design.

Lastly I give my warmest thanks to my very charming and supportive friend-husband, Sasan, who I appreciate with all my heart for his dedication and understanding towards the completion of my education.
Introduction

Working out and exercising has become part of our nature, culture, pleasure and even entertainment while improving the health of our bodies and minds. We generally believe that by attempting physical exercise and obtaining good nutrition, we will gain better overall health. Most of us spend a lot of time, money and energy to exercise, become a member of a local gym, play tennis or basketball for example, and get involve with physical activities on a daily or weekly basis to stay fit, healthy, strong and flexible.

Obviously physical activities help us reduce tension, lose weight, improve blood circulation, decrease risk of heart disease and increase physical capability and better overall health. One may ask why have we chosen to discipline and develop the body and not the brain? What can we do to enhance our productivity, thinking process and actions more accurately? What can we do to advance our overall health to a different level? What can we do to enhance the most responsible and complex organ of our body, the invisible muscle, the brain? Are there any weight lifting or aerobics exercise to boost its strength? Perhaps we just haven’t been thinking creatively enough!

It is now possible to locate and observe complex qualities of the brain. It seems that it is time for our society to face new possibilities and experience new opportunities to improve personal health and fitness. Perhaps find possible exercises to stimulate the brain for a better and stronger operation of networking between its tasks, memory, learning, and aging for example. We might be able to enhance the brain’s networking and conduct more accurate signal transmission, registering information, receiving and retrieving data in different part of the brain. Many studies have shown that there are ways to act to prevent memory loss, poor productivity, learning difficulty, and Alzheimer’s disease.

Brain scanning technology, brain mapping, brain analysis, significant research and studies that have been conducted up to date, have revealed extensive knowledge of the brain and it’s very specific activities, functions and behavioral
responses. According to different sources of Neurology studies, brain-mapping as one of the recent techniques and clinical tools that has been used in Neuroscience around the world, have made it possible for researchers to view the brain’s actions and it’s networks. It is possible to convert scan data almost instantaneously into an animated 3-D image showing what parts of the brain light up during mental activity. “Brain-mapping is a procedure and tool that records electrical activity within the brain. This tool gives the ability to view the dynamic changes taking place throughout the brain during processing tasks and assist in determining which areas of the brain are fully engaged and processing efficiently.”

Recent research and studies have shown that the more learning and activities the body and the brain experiences, the more synapses are born. The more synapses that are born, the more capable and stronger networking ability the brain will have. As we learn more about the brain, we will realize that many parts of the brain are engaged and activated at the same time to perform a single task or challenge, and the actual processes that take place in the brain are far more complex. Also, the brain is capable of reshaping and improving performance based on our experiences and our environment.

Exercising the brain in fulfillment of creating more synapses, improving memory, advancing personal performance and executive functions, and also enhancing brain health and fitness are the core concepts of brain fitness. This project is an attempt to publicize the idea that exercising the brain should become a habit and adjunct to our physical exercise activities. In other words, consistency is a key element in staying mentally fit and strong, just as we need to be consistent in doing physical exercises. We never become a body-builder in two sessions, the same holds true for brain function. Therefore designing a user-friendly brain fitness-gym prototype will be an offering to it’s supporters and members in supporting and improving their brain health and wellness.

Primary research for this paper is focused on scientific study and learning experience, and obtaining basic academic knowledge about the brain to build a reliable understanding towards design development in this project. This paper explores the brain structure and its functions, discusses what synapses are,
describes brain plasticity, the brain reserve, how memories are stored in the brain, and research why exercising the body and mind together are essential to achieving higher personal health and performance. Finally, presenting the possible plans, programs and schematic designs for the “i Fitness”, the brain fitness facility.
Chapter One

About the Brain

A territorial tour of the Brain

To develop the concept of a brain fitness, a sufficient knowledge of the brain and how it works is vital. In this section a basic understanding of the brain structure and its components is presented.

Rita Carter in her book “Mapping the Mind” explains the human brain as follows:

The human brain is as big as a coconut, the shape of a walnut, the color of uncooked liver and the consistency of chilled butter. It has two hemisphere, which are covered by a thin skin of deeply wrinkled grey tissue called the “cerebral cortex”. Each enfold on this surface is known as a sulcus, and each bulge is known as a gyrus. At the very back of the main mass of brain, tucked under its tail and partly fused to it, lies the “cerebellum” – the little brain. In the past, this was our mammalian ancestors’ main brain but now it has been superseded by the larger area, the “cerebrum”. Each half of the cerebrum is split into four lob, their divisions marked by various folds. At the very back lies the “occipital lobe”; in front of that is the frontal lobe. Each processes its own clutch of things: the occipital lobe is made up almost entirely of visual processing areas; the “parietal lobe” deals mainly with functions connected with movements, orientation, calculation and certain types of recognition; the “temporal lobes” deal with sound, speech comprehension (usually on the left only) and some aspects of memory; and the “frontal lobes” deal with the most integrated brain functions: thinking, conceptualizing and planning. They also play a major part in the conscious appreciation of emotion. If you slice the brain in half down the centerline so that the two hemispheres fall apart, “you see that beneath the cortex
lies a complex conglomeration of modules: limps, tubes and chambers. Each one of these modules has its own function or functions, and they are all interconnected by crisscrossing ropes of axons.”

“We can walk, talk, write, drive, cook, solve mathematical problem, make plans and play sport or music. We can understand poetry, economy, politics, world crisis and the complexity of our universe.” 4 “Scientists believe that the most important part of the brain for most functions is the cortex,” as Dr. Fotuhi states. 5

Figure 1: Brain lobs. Source: “Mapping The Mind”

The “cortex” and its functions as Dr. Fotuhi describes in his book The Memory
Cures, is “a thick sheet of cells sitting on top of brain and extending all the way from the front—behind the forehead to the back. This layer of cells has tight interconnections with other parts of the brain. It constantly receives information from them and sends out commands. He states that, the cortex on the right side of the brain controls the left side of the body, and vice versa. Also he describes: Each segment of the cortex seems to be more directly linked with one of the functions of the brain. For example, areas in the back of the cortex are more important for your vision. This area is called the “visual cortex.” The “auditory cortex” enables you to hear sounds, the “olfactory cortex” is for your sense of smell, the “somatosensory cortex” enables you to distinguish different tactile sensations, and the “motor cortex” gives you the ability to control your arms and leg movements. There are also cortical areas devoted to understanding language, producing speech, and recognizing faces”.  

In addition, Dr. Fotuhi notes that the more prominent folds of the cortex serve as landmarks for scientists. In other words, the visible surface of the cortex is divided into four subdivisions: The frontal, temporal, parietal, and occipital lobes, and the invisible lobe as the fifth lobe that lies deeper in the brain, called the limbic lobe, and that “each lobe consists of three to five different functional cortical areas. For example, the temporal lobe contains the cortical areas for hearing, understanding language, and memory”.

According to the recent research and studies of recent techniques: fMRI and PET, the “specific cortical regions are implicated when a person views an object, attends to color stimuli, processes words semantically, uses working memory or is involved in a number of different cognitive processes. These methods involve measuring changes in blood flow and are appropriate for assessing both the structural sites and the functional processes involved in cognitive tasks.”
Brain Functions

“The human brain is made of many parts. Each has specific function: to turn sounds into speech; to see color; to register fear; to recognize a face or distinguish a fish from a fruit. But this is no static collection of components: each brain is unique, ever-changing and exquisitely sensitive to its environment. Its modules are interdependent and interactive and their functions are not rigidly fixed: sometimes one bit will take over the job of another, or fail, owing to some generic or environmental hiccup, to work at all. Brain activity is controlled by currents and chemicals and mysterious oscillation; It may even be subject to quantum effects that distort time. The whole is bound together in a dynamic system of systems that does millions of different things in parallel. It is probably so complex that it will never succeed in comprehending itself. Yet it never ceases to try.” 10

According to recent experiments using new techniques such as functional magnetic resonance imaging (fMRI), PET imaging techniques or brain mapping, researchers have learned extensively about the human brain functions. While pictures of the brain in action can be captured, what results is a picture of the brain spotted with colored blotches in the regions that were active (figure 2). “These techniques are revolutionizing science and medicine, yielding a deeper understanding of a range of human experiences.” 11

To simplify what we can do to increase brain functions and abilities, the specific components of the brain are described below which are the focus of “i Fitness” (the brain exercise facility) and this paper:

**Frontal lobes** are the part of the cortex sitting in front of your brain, just behind your forehead. The cortex here gives you the ability to plan your day, organize your work, type a letter, pay attention to details, and control the movements of your arms and legs. It also contributes to your personality and your behavior.
Temporal Lobes are the part of the cortex sitting on the sides of your brain, just between your ears and temples. The cortex here allows you the ability to hear, understand language, and form memories. The hippocampus sits deep inside your brain, but it is still a part of temporal lobe.

Hippocampus is the part of your brain essential for making new memories. The hippocampus is the most unique part of the brain, not only is the most sensitive to drop in oxygen level, but it is also the first part of the brain to shrink with advanced age, thus explaining why memory lapses are more common in senior citizens.

The Cerebellum is about the size of an apple, it is tucked under the cortex in the back of the brain. It is linked with the ability to fine-tune movements so they become more accurate with practice. It’s also important for balance and coordination.12

Figure 2: Functional MRI has helped identify which bits of the Brain are involved in specific mental tasks. Source: “Mapping The Mind”
The Left and Right Brain

The brain is split into two identical-looking hemispheres that function in two distinct manners. It is argued that the right brain controls artistic, more abstract learning and thinking through visual means, while the left utilizes a more logical and sequential method of processing and exploiting information mostly acquired by verbal skills. 13

“It is true that the brain is marvelously complicated, and the constant interaction of its two hemisphere makes it extremely difficult to pinpoint what is happening where.... The brain is also very malleable and its wiring can be influenced by all sorts of environmental factors.... Nevertheless, brain imaging studies confirm that the two hemisphere really do have quite specific skills that are “hard-wired” to the extent that, in normal circumstances, certain skills will always develop on a particular side”. 14

Figure 3: The corpus callosum is a thick band of axons – 80 million or so – which connect the brain cells in one hemisphere to those in the other. The two sides keep up a continuous conversation via this neural bridge. Source: “Mapping The Mind”

Rita Carter considers the left brain as “analytical, logical, precise and time – sensitive.” Also she considers the right brain as the “dreamier” side of the brain.
She states: “the right brain processes things in a holistic way rather than breaking them down and it is more involved with sensory perception than abstract cognition”. 15

“To oversimplify just a bit, the left hemisphere handles what is said; the right hemisphere focuses on how it’s said – the nonverbal, often emotional cues delivered through gaze, facial expression, and intonation”. 16

Dr. Oliver Sacks, an author and neurologist has generalized characteristics of the left and right brain that are depicted in the chart next page:

![Figure 4: Right and left brain mapping. Source: Home & Garden Magazine](image-url)
Left Brain
Verbal
mathematical
responds to word meaning
intellectual
sequential
processes info linearly
responds to logic
objective
plans ahead
prepositional
recalls people's names
analytic
speaks w/ few gestures
punctual
prefers formal study setting
introspective
likes structure, predictability

Right Brain
visual, tactile, kinesthetic creative
responds to word pitch, feeling
intuitive
holistic
responds to emotion
subjective
spontaneous
imaginative
recalls people's faces
relational
gestures when speaking
less punctual
prefers music/sound while studying
likes open-endedness, surprises
extroverted
Brain Cells

Daniel Pink notes in his book, “A Whole New Mind”, about the brain complexity that: “The typical brain consists of some 100 billion cells, each of which connects and communicates with up to 10,000 of its colleagues. Together they forge an elaborate network of some one quadrillion (1,000,000,000,000,000) connections that guides how we talk, eat, breath, and move.” Daniel Pink James Watson, who won the Nobel Prize for helping discover DNA, described the human brain as “the most complex thing we have yet discovered in our universe”. 17

According to Dr. Fotuhi, the brain has two types of cells, neurons and glia. “Neurons are the main cells that send and receive signals. The glia cells support neurons and ensure that they can function without interruption…. Each neuron is shaped like an octopus with thousands of branches extending from it. One of these branches, the “axon” is thin and long and serves as the output of the neuron. The other branches, “dendrites” (Greek dendrites, tree branches), are often shorter and thicker and serve as input segments of the cell. The extensive combination of different – sized cell bodies and branching patterns results in a thousand different shapes of neurons in your brain” .... “Neurons in different parts of the brain talk to each other by sending and receiving (electrochemical) signals through these branches”. 18

Nancy C. Andreasen also explains in her book “The Creative Brain: The Science of Genius”, that the brain’s surface contains layers of nerve cells (neurons). “The neurons are lined up in six layers throughout most of the cerebrum”....”This six–layered collection of nerve cells on the outer surface of the brain that looks darker than the rest of the brain in brain slice, is referred to as gray matter, or the cerebral cortex (Latin cortex, bark of a tree)”. 19
Dr. Fotuhi believes, “Building a stronger brain” can be achieved by performing mental and physical activities, and learning new things.

Recently for the first time, scientists have provided convincing evidence that “each of the 100 billion cells in the human brain has the capacity to grow new contact points with its neighbors and contribute to a more complex and richer network of interconnections. As such, the brain’s capacity is endless…. Brain cells are a lot like muscle cells. Muscles grow stronger and larger with exercise. Similarly the brain becomes stronger and larger with challenging mental activities. In both cases the more they are used, the more powerful they get”.  

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Figure 5: Major components of a typical Neuron. Sources: NIAAA
Synapse

The connection points between neurons are defined as synapses. “Synapses are the discrete points that nerve cells use to connect to one another to send information back and forth”. 21

In other words, “the junction point where the end of an axon comes to almost touch the dendrites is called synapse (Greek synaptein, to fasten together). Each individual neuron receives thousands to millions of input (synapses) from other neurons and itself can send out thousands to millions of synapses”—“The number of these synapses increase when you learn something new or when you experience something dramatic”. 22

If you learn a new language or practice a new instrument for the first time, new synapses would form in the brain. The existing synapses also would become stronger, and as a result you have a more efficient connection in the chain of neurons and more complex signals sending information back and forth. Therefore learning more in a stimulating environment is associated with the birth of new synapses in the brain.

Figure 6: Brain cells communicate with each other through contact points, called synapse.

Source: “The Memory Cure”
Chapter Two

Brain Potential

As Dr. Fotuhi noted in his book, “there is far more potential in the brain than one can imagine.” Just by looking at the accomplished people in sports, arts, science, or medicine illustrates how an individual can produce amazing results. This chapter outlines emerging new concepts of the brain: brain plasticity, brain reserve, brain growth, aging, neuroscience creativity, storing and retrieving memory.

Brain Plasticity

The developing brain is plastic. “The term plasticity has been applied to processes operative at many levels of the neural and cognitive system”, states Dr. Joan Stiles in one of his articles.21

Nancy C. Andreasen, a psychiatrist and neuroscientist explains the brain plasticity in her book: “the brain is marvelously responsive, adaptable, and eternally changing. Its adaptations and changes occur in response to the demands and pressures of the environment that it encounters”.... She notes, “Sigmund Freud and the psychoanalytic movement gave us an awareness that early life experiences affect emotional development and attitudes in later life. Neuroscience adds a new dimension: it makes us aware that experiences through life, change the brain throughout life. We are literally remaking our brains – who we are and how we think, with all our actions, reactions, perceptions, postures, and positions – every moment and every day in our entire lives”.24 In other words, according to her, we accumulate a collection of experiences and memories throughout our life, and literally what we have seen, read, heard, smelled, and touched, has shaped our mind and brain to make us who we are.

In a very simple overview, brain plasticity is the brain’s capacity to learn,
change, and adapt. “This occurs simultaneously on the fine-scaled level of molecules and on the large-scale level of brain systems”. 25

One important part of brain plasticity is the ability to retain and store specific memories. “Preservation of memories over the short term occurs because existing synapses are strengthened. Long-term memory storage must be produced by the creation of new synapses…. Neuroplasticity or brain plasticity refers to the brain’s ability to CHANGE throughout life. The brain has the amazing ability to reorganize itself by forming new connections between brain cells (neurons). In addition to genetic factors, the environment in which a person lives, as well as the actions of that person, play a role in plasticity. 26

Also Dr. Fotuhi in his book “Crosswords to keep Your Brain Young”, relates the role of brain plasticity in adulthood to “the flexibility of the brain in altering its properties, both at a microscopic and a structural level.” He notes that, “the belief that learning new skills only effects brain development in children has now been shattered. Hundreds of scientific studies and countless common day-to-day observations have revealed the brain’s ability to adopt to life’s challenges under different conditions”. 27

A concise explanation of brain plasticity is that brain capacity tends to change with learning, and new adaptation throughout life. Accordingly, by influencing this plasticity with the right training, learning new things and activities, improving concentration and memory, it is possible to gain better brain function. Thus “i Fitness” can acts as a movement toward increasing the plasticity of our contemporary society.
Brain Reserve

The concept of “brain reserve” refers to “the idea that throughout your life you accumulate more and more synapses as you challenge your brain and learn new things. This pool of synapses serve as a reserve for your retirement years. The more synapses you have formed throughout your life, the better you can handle damages to your brain”. 28

“In essence, an individual who uses a brain network more efficiently, or is more capable of calling up alternative brain networks or cognitive strategies in response to increased demand may have more cognitive reserve”. 29

Figure 7: Brain Reserve. Source: “The Memory Cure”
Brain growth

How does the adult brain grow when new skills are learned? Specific protein nutrients are released inside the brain when it is presented with a new challenge. These proteins, called “growth factor”, help nourish the formation of new synapses. As more synapses are created, the communication between networks of brain cells improves. This allows you to learn and perform the new task more easily. When a consistent stimulation and training occurs, there is a noticeable increase in the number of synapses, and “the brain areas more closely linked to the nature of the stimulation become large enough to be detected with imaging techniques. Some scientists believe new brain cells are also created in the process of brain plasticity and growth, but the exact detail remain unknown. 30

Figure 8: Online Source: www.braingrowth.info

Aging

While we learn more about the “brain reserve” and allowing ourselves to store more brain cells and synapses, there will be an optimistic picture for achieving successful aging also. According to Dr. Fotuhi, “With aging, some wear and tear in the brain results in loss of synapses. However, those who began with more synapses in their midlife have the capacity to resist and outlast any loss of synapses in late life”. 31
Neuroscience creativity

“Creativity is a phenomenon that allows human to invent, solve problems, and evolve.” Dr. Oliver Sacks. 32

“Creativity is the power or ability to invent or come up with new ideas. Everyone has the ability to be a highly creative person. You just need to learn how to unlock it! Practicing this skill is a good way to stretch your mental muscles and expand your imagination.” 33

Until very recently, studies of the neural basis of creativity have been all too rare. But now by examining the neural process underlying thinking in general and creativity in particular, neuroscience can potentially take us to the very essence of what creativity is. The opportunities offered by neuro-imaging to understand the creative brain. We now know that when we store memories, learn or solve problems, we increase the number of synapses and that might actually translate into an increase in the volume of gray matter in the specific regions where the synapses increase. 34

Figure 9: Online Source: www.Corbis.com
Storing and retrieving Memory

“Memory is one of the most fascinating functions of the human brain, from children who entertain themselves with memory games and songs to adults who strive to recall the details of an increasingly complex world”. 35

The part of your brain essential for hearing, seeing, thinking, speaking, writing, solving problems, and making plans is called the cortex. This is also where the sights and sounds of old memories are stored. 36

Understanding how the brain and the memory work is a necessary step to learning how to stimulate the brain in order to improve the memory. Dr. Fotuhi, who is a neurology consultant in Alzheimer’s disease research center at Johns Hopkins Hospital, in his book “The Memory Cure”, defines the memory as “a reflection of one’s whole life”, “your memories come to the surface when you hear the voice of an old friend or see a picture of your childhood home”(3). He explains; the cells in your brain are the same ones you were born with. They witness with you all that you experience over decades of your life. These brain cells are what meditate your sense of vision, hearing, and taste, as well as your experiences of joy, frustration, sadness, success, pride, and, of course your memory. 37

The cells in different part of the brain have divided the responsibilities for making new and different forms of memory; long-term memory, short-term memory, and procedural memory:

**Long–term memory:** There are three stages in making a memory that lasts from hours to decades: acquisition, storage, and retrieval. To remember a name or an event, you first acquire that information in some parts of your brain, and then you store it in other parts. Once stored, you have access to that information and can retrieve it at any time…. You acquire information from the world around you – mostly through your eyes and ears in your “hippocampus”, and you store them in your “cortex”.

In fact there is one hippocampus on the left side of the brain and one on the right side (figure 10). In the hippocampus, a subset of information-pieces
that are relevant to you gets etched more firmly and is then sent to other parts of the brain for long-term storage.

The part of the brain that retrieves the information from the hippocampus is the cortex. On a daily basis, you encounter thousands of pieces of information, but only the pieces that are meaningful and significant are likely to make an impression on your hippocampus and get shifted to other parts of your brain for storage in Long-term memory.

**Short– term memory:** includes the information that reaches the hippocampus but doesn’t get stored in the cortex, in other words, the hippocampus doesn’t consider them worthy of long-term memory. You subconsciously erase all the information that is not meaningful to you. The hippocampus is the gateway for the information of new memories. In a simplified computer analogy, it works as RAM (Random Access Memory), where information is kept for a brief period of time, and the cortex serves as the hard disk where permanent memories are kept.

![Figure 10: Hippocampus and Cortex. Source: “The Memory Cure”](image-link)
**Procedural Memory**: the third form of memory is Procedural Memory. For example, when you first learn how to peel a cucumber, tie your shoelaces, or learn to dance, you acquire new skills by physically performing the same movement over and over again. Procedural Memory is operating whenever you have to repeat certain hand or leg movements to learn something new. You could never perform these movements well just by reading about them or watching them on television; you must physically do them. Learning new dance steps or learning how to use chop sticks to eat Chinese food takes place in the “Cerebellum”.  

In summary, what we can do to strengthen our memory and become better at learning and remembering, regardless of our age, is to engage our memory to increase attention, enhance concentration, become more motivated, and determined.

“There’s no reason why you cannot maximize your mental fitness – just as you can maximize your physical fitness – at any age.” Dr. Majid Fotuhi
Chapter Three

Exercise your Brain, it acts like a Muscle

The idea of exercising the brain is very simple; if we choose to expose ourselves to new challenges and tasks, we help our brain expand and reserve more productivity for our senior years. As Dr. Fotuhi indicates that, “improving brain function is just as easy as improving muscle and physical fitness. The only reflection of the growth of new synapses in your brain is the ease with which you perform tasks you initially found challenging. A musician, a wine taster, a dancer, a taxi driver, and a carpenter all have the same brain anatomy, but for each, some parts are more developed and refined than others”. 40

Also physical exercise can help to stretch the brain capacity. Captured biological evidences done by brain MRIs, have shown that people who exercise regularly cultivate more powerful brains. According to some studies of young volunteers at Columbia University who exercised for three months, they found a significant improvement in the size of the hippocampus, the part of the brain responsible for memorizing names, faces and direction.

“No matter your age, a strong and active body is crucial for building a strong and active mind. Though hard to believe, some parts of your brain actually increase in size after several months of regular exercise”. 41

There is no doubt that physical exercise improves blood circulation to our brain, lowers bad cholesterol, levels blood pressure, lowers the risk of stroke, and enhances metabolism. It seems to have a more powerful effect than any medication without causing any side-effects. In line with the initial concept of the project of raising the cognition and productivity of the brain, we also need to consider emotional and mental well-being. It is essential that mind and body work together.
It is our responsibility to pay consistent attention to our body while engaging in brain activities, tease our brain, solve crossword puzzles, play games, or even try to fix things around the house to stay both physically and mentally fit and healthy.

We know now, training on a specific cognitive task improves subsequent proficiency in that task, and most importantly constant training is required in order to maintain an advantage, and long-lasting effect.
Chapter Four

Connect with your Inner Mind

“Whenever an answer, a solution, or a creative idea is needed, stop thinking for a moment by focusing attention on your inner energy field. Become aware of the stillness. When you resume thinking, it will be fresh and creative. In any thought activity, make it a habit to go back and forth every few minutes or so between thinking and an inner kind of listening, an inner stillness. We could say: don’t just think with your head, think with your whole body”, Eckhart Toll. 42

In addition to the complexity of the brain’s functions and its components noted in previous chapters, recognizing the structure of our thought process is essential. The vast perspective of the whole thought process, conscious, subconscious and unconscious mind require a completely new project type. However since the idea of the “i Fitness” is considering health and wellness of brain and mind together, a brief explanation of the mind structure and suggested exercises for a healthy mind are as follows: Consciousness and subconscious Mind, practicing Tai Chi, and Yoga.

Conscious and Subconscious Mind

“The brain engages in several different kinds of thought. One is what we call “ordered” or “conscious” thoughts. This is the thinking that we use when we perform specific mental tasks, such as producing spontaneous speech when answering a question or telling someone a story”. 43 “Your conscious mind is the reasoning mind, also it is referred to as the objective mind because it deals with outward objects. The objective mind takes cognizance of the objective world. Its media of observation are the five physical senses. The objective mind learns
through observation, experience, and education.

While your subconscious mind is the seat of your emotions and is the creative mind in some beliefs. The subconscious mind is often referred to as your subjective mind. Your subjective mind takes cognizance of its environment by means independent of the five senses. The subjective mind perceives by intuition, it is the seat of the emotion and the storehouse of memory.”

The concept of the human mind is vague and has arguable components among neuroscientists, because it can not be totally studied using scientific methods yet. However the human mind, insight and mental activity have had the world’s attention and been a topic for philosophers of all time.

“No doubt: The human mind is highly intelligent.” Tolle, Eckhart.

Tai Chi

Tai Chi as an integrated exercise with the science of body structure, therefore it is one of the physical and mental trainings that is offered at “i Fitness” to benefit brain and mind health together.

“T'ai Chi Ch'uan (pronounced Tye Gee Chwon) has a long history. Its roots go back into the Chou Dynasty (5th Century B.C.), when concern for physical and mental health was being expressed in a philosophy of movement” (28). But the more modernized exercise of T'ai Chi that we know today dates from a couple of centuries ago. “T'ai Chi has matured from the philosophical concept that the mind and body affect each other to the mutual advantage of each; that to increase the ability to concentrate and coordinate is to raise both mental and bodily powers; that equanimity (heart – mind – ease) must be part of, and the result of, the exercise – action”. 46

Sophia Delza in her article: “T'ai Chi Ch'uan: The Integrated Exercise”, notes that
“the variety of the Tai Chi structures puts every part of the body into play, from the smallest joint to the largest muscle .... The natural changes of dynamics are determined by changing position, with stillness (Ying) and action (Yang) combined. The total Form is sensed as being "just right" when one gets the feeling of the impeccable balance of design – shape – movement dynamics. This feeling is especially agreeable when the mind is quietly focused”. 47

**Yoga**

Yoga will also be suggested at “i Fitness” as a mind–body practice which will help us release tension, reduce stress and become relaxed while engaging in physical exercise.

A well–functioning body is not enough; a developed–communication system between mind and body is the key point of health. Learning about the brain and also the effects of mind-body practices on the brain, will help us to manage better our flexibility, sensitivity, profundity, and overall health.

“By learning to become the master of your brain, you become the master of your life.” 48
Interview with
Dr. Majid Fotuhi

I have been fortunate to meet with Dr. Majid Fotuhi to discuss my project and be assisted by his vast insights and advice.

Dr. Majid Fotuhi currently is the Director of the center for memory and brain Health at LifeBridge Health Brain and Spine Institute, at the Department of Neurology, Sinai Hospital of Baltimore, Clinical instructor at Harvard Medical School, Harvard-MIT division of Health Sciences and Technology, and assistant Professor of Neurology at Johns Hopkins University School of Medicine. He is also the author of two books: “The Memory Cure”, and “Crosswords to Keep Your Brain Young”, which were used as the main references for this paper and project.

The meeting took place at the Michel Mirowski Medical Office Building in Baltimore. The purpose of conducting this interview was to gain more academic support and obtain guidance from someone who is knowledgeable about the topic of this project. The result of this interview was very encouraging and helpful. Surprisingly Dr. Fotuhi mentioned that he has been thinking and programming for a brain fitness facility himself and that my project may be potentially used for a real model in the future.

At first I presented my program and my suggested diagram about brain fitness to Dr. Fotuhi and below are his thoughts, questions and answers about brain fitness:

Dr. Futuhi: Something to remember is that, the brain is like intertwined network of connections. It is not like part A does function A or part B does function B. However in that context there are still some areas that serve specific functions; such as the frontal lobe has to do with decision making for the most
part, executive functions, and control, or some part of the temporal lobe has to do with memory and language. Your right brain is indeed for design and art, and the left brain for more radical things such as mathematics, so there are some generalizations. You may, instead of working on what part of the brain does what find out what different parts of the brain can do for each other, like the idea of cross-training.

It is just like in a gym that you can do biceps to work on one muscle or play tennis in which you are cross-training so many muscles at the same time.

The information about the brain is something that you can use to entice people as they come in, you need to provide information such as plasticity which means if you work on your brain, it actually gets better or talk about brain reserve, so it is possible to delay Alzheimer’s or prevent it.

For the frontal lobe you can have things that require problem-solving such as mazes and brain teasers. You actually tickle your brain by engaging yourself in solving problems. For example, when you prepare for your exams that require you to memorize a long list of things, your brain will be in a better shape than before. As a matter of fact one of the studies on medical school students show the brain volume; certain part of their brain increased it’s size. When you stop using it, it goes back, if you use it again it goes up; if you keep using it, it stays in a bit higher than it was before. So volume increases, obviously your brain volume doesn’t increase beyond the size of your head. After all it is a muscle, and muscles never go beyond certain amount. When you continue to exercise, you tone up the muscle and it remains stronger.

Cerebellum is responsible for balance and coordination. So the kind of things that can be done here is the reaction time. There are software for these kind of things. Also the balance bars are good to be provided; you need your brain to maintain your balance.

• What do you think I should include in my brain health station?
In the brain health station, you want to talk about the brain health. You want to talk about the importance of blood pressure. The people with high blood pressure
are more likely to get demented and have brain problems. Also physical exercises are as important for brain as brain exercise for brain, because physical exercise increases the blood supply to brain. Another important fact for brain health is diet. If you have two gallons of Coke and two hamburgers before you come to the gym, first of all it is not going to work and secondly it is just defeating the purpose.

- What does plasticity mean?
  Plasticity means that the brain is not a fixed structure. Your nose is fixed throughout the life (your adult life), but your muscles are changing, they have plasticity, they can expand, they can shrink. In the brain, the receptors (the brain cells) have extensions that called axons, when they come near cell they form a synapse.

- What is synapse?
  Synapses are contacts between brain cells. The more contact points you have within your brain, the more complex and richer network your brain become. With synapses you allow more communication between the parts of your brain.

- Can one make more synapses by exercising?
  Yes, with learning something new. Lets say you learn a new language, learn an instrument, or just a new piece on the piano; a new segment by itself can cause creation of new synapses. Let’s say how do you go from home to work, and assume you learn three new ways to getting there, if something happens and one way is blocked, you have more interconnection and more ways of how to get there. You can still function if part of the road is blocked or part of it is gone.

- Do you loose synapses by aging?
  By aging you loose synapses, It is important to know that with aging you don’t loose cells, with aging you will have less intricate connections between the nerve cells. Creating more synapses help to compensate. With aging it happens that people can’t think as fast and they may not as quickly memorize a phone number because there are some loss of synapses. With age there will be some shrinkage, it actually weighs less, about 20% sometimes. That’s why the longer you
keep your brain busy, the longer you brain stays strong.

- Do you think exercising can be considered as learning? If you solve a puzzle you always learn something, because when you solve the same puzzle for the second time, you are a little bit faster, because you learned it. You learned it, because you worked on it.

- How do you improve the parts of brain that seem to act weaker than other parts? You take things that are more difficult to you and do more of it. It’s very simple, if you have difficulty remembering names, then you practice remembering names. I found a lot of time when people think they can’t, they can, they just don’t help themselves enough. The part of the brain inside the temporal lobe that is called hippocampus is for short-term memory. Playing with words and crossword puzzles can help improve memory. Language is a good thing, it uses a lot of mental processing.

- What do you think of naming the stations? You should come up with new and fun names for your stations. You have to raise people’s curiosity.

- Can you improve creativity? Creativity is like consciousness, we also know what it is, but we can’t put our fingers on. Creativity means problem solving, coming up with new way of solving problems is creativity to me.
Summary

Now that we know improving brain function is similar to improving muscle and physical fitness, we are able to boost our brain, help it grow new synapses and ease our challenges on performing daily tasks and activities.

Now you may ask why can’t we do brain exercises regularly through games and computers at home? Well the answer is yes you can, if you engage yourself to do your crossword puzzle while having your morning coffee, taking a dance class or decide to invest on brain software games. As a matter of fact there are amazing online brain training programs now that you may sign-in and workout your brain as long as you want. But the whole idea is to step out of your comfort zone. The idea of exercising in a brain fitness facility is very similar to exercising in a conventional gym; it brings the information and activities into an integrated concept. You will have interactions with people and groups while learning about the brain, be challenged with new experiences in an active and encouraging atmosphere, and have an adequate training process while enjoying an attractive and novel space.

The brain fitness, allows us to workout our brain on a regular basis, and makes our brain a more sophisticated and user-friendly working machine.

All the complex details and abilities of the brain have not been discovered yet, many mysteries still remain, but the important thing is how well we use what we know.
Summary of brain fitness benefits:

- Improves number of synapses
- Enhances memory
- Causes more brain “reserve”
- Increases the level of growth factors in the brain
- Develops communication and networking of the brain cells
- Decreases risk of dementia
- Keeps the mind fit
- Sharpens senses and actions
- Reduces stress
- Improves blood flow to the brain
- Helps you become more productive
- Provides a new hobby
Fitness Overview

i Fitness, the function-based brain fitness activity center divides its space into seven different stations. Each station is specifically designed to fulfill specific brain function upon the latest information and studies conducted by neurologists and researchers around the world. Engaging and stimulating the brain in different exercises, will evoke a cross-training affection in the brain, which enhances brain networks, creating more synaptic interconnections and perhaps the birth of new cells.

Each station is color-coded and a directory for each station is located by the entrance inside a structure of a brain. People may view their performance after completing their games and exercises if they desire to keep track of their progress and development.

The provided brain programs, games and puzzles will be out-sourced from various organizations such as the Lumos Labs, a cognitive neuroscience research and development company that builds software tools for improving brain health and performance. Lumosity is the first general brain fitness program from Lumos Labs. The board of scientific advisory of Lumosity consist of a number of leading neuroscientists in the world, who specialize in creating innovative applications of the latest developments in brain science, since its formation in the spring of 2005.

The other brain program provider is HeadStrong Cognitive Fitness Center, which is a company developed in Australia with American origins. Their online clinic offers extensive brain training programs and products that combines neuropsychological practice, neuroscientific research and computer technology to create their brain programs. Their products and services are available to be licensed to individual practitioners or larger organizations.
The following section describes the stations in detail:

**Brainfo Station**

*About the Brain: Focuses on Intelligence:*

Once a visitor has entered the brain fitness center, they are greeted by a large scale transparent human brain structure. This playful structure engages visitors to learn about the brain anatomy by walking or climbing around it. The outer brain layer (brain cortex) contains sensors for each part of the brain that can be exercised. As the surface is touched, it lights up to the color coding of the station that it relates to. It also displays some brief information about that section which helps visitors to decide on what part of their brain they may choose to exercise. For further information, there are two large touch screens in this station as it called “brainfo” station to provide an opportunity for visitors to interact and learn about their brain in more detail. The information focuses on how the brain works, brain plasticity, and brain reserve.

This space provides both a 3-D directory of the facility and an informational booth to build on the learning experience.

**Frontalsolve Station**

*Frontal Lobe: focuses on Problem Solving:*

The Frontal lobe, which is the largest and most anterior part of the brain, is associated with the executive functions, problem solving and ability to think. This station is equipped with mazes and brain teasers that are provided by touch screens both on the walls and the floor. The floor mazes are displayed in a two feet square screens which give an opportunity for both individual or group involvements. This station engages the brain in solving cognitive problems. The programs are varied from time to time and offer different level of difficulty as individuals progress to more challenging levels.
Temporal Lobe: Focuses on Memory and Language:

The Temporal lobe is located at the lower side of the brain, near the ears. It is involved in speech, language and responsible of the short-term memory. Studies have shown that one of the most efficient ways to enhance brainpower is to improve vocabulary. Therefore, this station encourages visitors to exercise their Hippocampus (STM) through word-finding, crosswords and puzzles which are displayed on large screens and captivate individuals or groups of people to solve them. The programs randomly change from basic to advanced levels.

Cerebellum: focuses on Balance and Concentration:

The Cerebellum, serves the balance and coordination function as it is dedicated to the timing of muscles and movements of the body. “The cerebellum has billions of connections with different areas of the cortex to monitor and control hundreds of muscles”. Therefore multi balance training tools and equipments are supplied for this area. This station fosters interaction and physical activity while exercising balance and coordination.

Brain Health: focuses on brain and mind health together:

The brain health station, is one of the core elements of the concept. We know chronic stress and high blood pressure will harm the brain in the long run. Today many people feel stressed on their jobs and the fast paced lifestyle associated with our time. The focus of this station is to encourage visitors to learn about brain health: blood pressure, the necessity of physical exercise, diet and stress reduction through videos and visual devices. Also, this station provides classes and trainers to engage people to practice Yoga and Tai Chi; exercising mind and body function together.
The hydration station, is a water and fresh–squeezed juice bar.

Lounge station will be located near the Hydrafresh station; where the members can rest, socialize or share their experiences.
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Fotuhi, 2008, 39
Appendix A

Name and Logo

The Gym has been given the name “i Fitness”. The “i” part of the name is simply representing two main elements of this project; “i” as it represents “individual” and also “intelligence”. Intelligence as it represents the brain. The “Fitness” supports the condition of becoming fit towards the “i” elements!

The logo is graphically make the “i” stands out as an important figure of the concept, the obliqueness of the “i” gives it dynamic structure and the color orange gives it an energetic and strong affection.

Designed by: Bita Salehi
Site Selection

Brain fitness is to be built for the first time! The idea requires a high traffic site, possibly close to public transportation in order to attract the most attention as a new available public facility in regard to exercising the brain.

It needs to be spacious enough to accommodate all the activities mentioned above. Also, I thought it’s important to be built either as an expansion of an existing gym or near one as it is going to be a similar prototype of a gym. Another benefit of being close to a gym is that brain fitness similarly will be consumed as a daily basis activity.

I initially selected six different gym locations in DC and studied their advantages and disadvantages based on above mentioned criteria. I finally found the “RESULTS GYM” which has the most potential to be my site location for this project.

The building 1101 is located on the corner of Connecticut Avenue and L street in North West of Washington DC. The building is accessible from the Farragut North metro station. The “RESULTS GYM” occupies two fully equipped levels under the ground of this building where the first level of the gym will be transferred to “i Fitness” and the second level remains the same. The first level has about 8,000 square feet of available space and is large enough to accomplish the activities designed for brain fitness.
Typology

I will consider the design of the “i Fitness” a successful design when I can merge the technology, science, human need and novelty all together within its space.

Finding guide lines and typology for this project was a challenge for me. The uniqueness of the project requires a unique design that will incorporate creative space-planning and displays for transferring information and learning experience, while dynamic and active pursuits like a gym, encourages activity and willingness to exercise. Therefore this brain fitness could be a hybrid of a gym and a museum; where members can come to exercise and interact on a regular basis like a gym and also explore and learn about the brain like a museum.

This new prototype will be a novel and innovative space in its own. The overall design concept of this space will be structured in a way to fulfill brain functions. In other words, the space will be divided into several stations in which allow individuals to encounter and challenge specific area of their brain as they desire to achieve more development and strength for that area.
Site Floor Plan

First Floor Plan

Fitness
By Bita Salehi
Conceptual Images

Fitness
By Bita Salehi

Bita Salehi. Thesis 2009
Bita Salehi. Thesis 2009
Schematic Diagram

- Brainfo
- Frontalsolve
- Tempormemo
- Lounge
- Chillax
- Hydrafresh
- Cerebalance

Executive Functions
- Problem Solving
- Ability to Think

Memory Formation
Language
Visual Processing Center
Balance Coordination
Integrating Sensory Information
Appendix D

Sustainability

Also this project will use sustainable and low-impact materials and will try to meet LEED standards, such as:

**Access floor** can be an integral design choice for creating accessible utilities, and highly sustainable environments. TecCrete® access flooring from Haworth is a modular system of architectural floor panels installed on pedestals above the structural floor to create an easily accessible underfloor space. Access floor will be used throughout the “i Fitness”.

The below applications will contribute to LEED points:

- **Wiring Systems**: The use of access floor simplifies the installation of power, network, video, and other digital wiring. The wiring systems are run at floor level where they are needed, eliminating the necessity for power poles to bring cables from the ceiling down to floor level. (see next page)
**Underfloor Air Distribution:** Underfloor air distribution systems are a general class of air distribution systems that deliver air through diffusers in the floor, with the intent of maintaining comfort and indoor air quality levels only in the occupied lower portion of space with return grilles located near the ceiling.
• **Indoor Air Quality:** Concentrations of carbon dioxide, airborne bacteria and off-gassing contaminate in spaces served by underfloor air systems are typically much lower than those served by overhead systems.
Appendix E
Final Presentations
SUSTAINABILITY

Bita Salehi. Thesis 2009
SITE

PROGRAM

SCHEMATIC

Bita Salehi, Thesis 2009
MODEL

CLOSE UP

RENDERING
Scientists have provided convincing evidence that each of the 100 billion cells in the human brain has the capacity to grow new contact points (synapses) with its neighbors; creating a more complex and richer network of interconnections. The brain’s capacity, referred to as brain plasticity, tends to change and improve with learning new things, and new adaptation throughout life. Engaging and stimulating the brain in different exercises, will evoke a cross-training affection in the brain, which enhances brain networks and creating more synaptic interconnections. Accordingly it is possible to achieve a better brain function. Therefore the idea of “fitness” is born.

**FACT**

“Fitness” is a workout gym to higher the executive functions of the brain, improve personal performances, enhance memory and prevent diseases such as Alzheimer’s, which is a concern of about seventy-six million baby boomers and others. In addition, the moral component of the brain fitness facility is that it will encourage people to improve their behavior and enhance their vision of themselves, our society and our planet.

**GOALS**

The idea of designing a brain fitness facility is to increase an interest in exercising the brain casually in everyday life, as consistency is a key element in staying mentally fit and strong, just as we need to be consistent in doing physical exercises. “Fitness” is a hybrid space where brings the information and activities into an integrated concept and will allow people to be challenged with new experiences and trainings while enjoying a dynamic and novel space.

Brain is like a muscle; it needs exercise!

**SUMMARY**
9x9 Concept Board