

MIB-X

THE ULTIMATE MIND GAME

THE SECRETS OF THE
HUMAN BRAIN &
ITS ABILITIES HAVE
CONFOUNDED SCIENTISTS
SINCE AGES. BUT EXCITING
NEW RESEARCH IN BRAIN
MAPPING PROMISE TO
CHANGE THAT AND MUCH
MORE BY ASHISH KUMAR



It's a general refrain from the coach/captain of the losing team (*it is especially useful if the team was the underdog, or the players are relatively young and inexperienced*), be it any sport – that the boys were under too much pressure to perform, and the occasion just got the better of them. You may have great textbook potential, with every player of the team a match winner on his day, but it's all about how the team clicks in a particular crunch situation. In cricket, for instance, the South African team has earned a tag that they desperately want to shake off – the choker tag. And if you watch matches played by the Indian team in the late 1980s and early 1990s against teams like West Indies, Australia, England and even Pakistan, you would have thought pretty much the same for them. Individually, even the all time great Sachin Tendulkar has faced the flak for capitulating in the nervous nineties. Considering how the hopes of a nation have been on his shoulders all the years, can you really blame him?

However, these 'facts of life' may be history in the coming years. Research conducted by US-based scientists Dr. Brian Miller and Dr. Wesley Clapp on the functions of the human brain aims at using functional Magnetic Resonance Imaging (*fMRI*) technology to understand how athletes take on the mental challenge during a competition, which special portions of the brain work when it comes to taking a split second decision in a high pressure situation (*like a penalty shoot-out or a tense final over*), or, in broader terms, how human beings learn & apply. Results of this kind of work can initiate an altogether new era in mankind. Once

PEOPLE ARE BEING TAUGHT HOW TO ACTIVELY MANAGE THEIR NEURO-SYSTEMS USING SOUNDS & IMAGES, WHICH CAN AID IN DEVELOPMENT OF BASIC LEADERSHIP SKILLS

we are able to zero in on the neurological elements responsible for performance in sports, we might also be in a position to alter these elements to achieve a higher performance in other facets of life apart from sports.

Welcome to the new and exciting world of brain mapping. For the uninitiated, brain mapping can be understood as a set of techniques, which can generate a spatial representation (*map*) of the biological quantities present in the human or non-human brain. These maps can then be utilized to study various functional aspects of the human brain (*which possesses at least around 100 billion neurons and support cells*), and which functions correspond to specific areas.



For this purpose, many imaging techniques like PET (*Positron Emission Tomography*) scans, functional MRI (*Magnetic Resonance Imaging*), CT (*Computed Tomography*) scan, EEG (*Electroencephalography*), MEG (*Magnetoencephalography*) and NIRS (*Near Infrared Spectroscopy*) *et al* can be utilized. These techniques have their own pros and cons. For instance, the electrodes of an EEG sit on the surface of the head and cannot offer visuals deep inside the brain. On the other hand, *fMRI* uses a powerful magnet to track the blood flow throughout the brain as test subjects respond to visual, audio, or even taste cues. But the use of *fMRI* can cost about Rs.60,000-80,000 per hour and may require subjects to lie very still inside a machine, which can be intimidating. EEG is far less expensive & subjects can also move during tests.

Indeed, the brain is a complex subject, and it has been particularly daunting for scientists to understand how it functions.

The 100 billion neurons that we talked about are just the starting point. Scientists now admit that the brain has at least 1 trillion glial cells, which are equally important as they amplify neural signals. Each neuron can connect with millions of others through what are called synapses, and it is estimated that our brain forms around a million new connections for every second of our lives. Understanding all these connections and how they may affect human behaviour at a particular point in time may seem outlandish at best. But some progress is visible.

Initially, brain imaging techniques were developed as a way to study neuro-chemical activities in a brain without going for invasive neurosurgeries. Today, the scope of such imaging techniques has widened to the extent that scientists are looking to predict or alter the way the human brain functions. A research paper written by Desney Tan and Anton Nijholt for Microsoft Research says, "Advances in cognitive neuroscience and brain imaging technologies have started to provide us with the ability to interface directly with the human brain. This ability is made possible through the use of sensors that can monitor some of the physi-

cal processes that occur within the brain that correspond with certain forms of thought."

In theory so far, attributes like confidence, fear, shyness, anxiety *et al* can all be modified. Dr. Erika J.C. Laing, who works as Clinical Associate at UPMC Brain Mapping Center, USA and conducts cognitive research of various psychological phenomena is extremely optimistic about it. In an exclusive interaction with Tech Next, she says, "It is not all that distant actually! Neuroimaging already plays a key role in helping us understand the neurological underpinnings of behaviour, and some of the most exciting research pairs neuroimaging with another type of neuroscience work that assesses the function of neurons at the cellular level." However futuristic it may sound, researches in the pipeline point towards the start of a totally new and exciting era. So the logical question that follows is, "What's on the table so far?"

Consider the debate on whether leaders are born or made, which has been going on for ages. The debate may near its end soon. Dr. Jeffrey Fannin, Executive Director, Center for Cognitive Enhancement and Pierre Balthazard, Associate Professor, Carey



(Left) Brain mapping may address the 'choker' challenge faced by South Africa's cricket team & (Below) Researchers have observed that people associate the front of the BMW Mini Cooper with a human face



ONCE ALL THE ATTRIBUTES OF THE BRAIN ARE MAPPED PROPERLY, OUR BRAINS WILL BE AVAILABLE IN A SOFT COPY

School of Business at Arizona State University have spent more than 10 years in an attempt to understand the neuro-scientific aspects of leadership skills in an individual and whether it is possible to use neuro-feedback training to help people become better leaders. People are taught how to actively manage their neuro-systems using sounds and onscreen images. Once they master this, significant changes can be found in their brain maps. This can lead to development of basic leadership attributes in people who didn't possess them earlier. Dr. Jeffrey Fannin's work also includes studying the waveform patterns of the brain, which get generated with the help of EEG; so that the required transformations can be made in this pattern to achieve changes in factors like attitudes, emotions, learning speeds and capacity. In a way, it is conditioning the brain to work in a manner that's different from its natural course.

Advancements in brain mapping are further endowing researchers with hitherto unimaginable insights. Memories of the 2009 Hollywood blockbuster *Avatar* have not yet faded from

memory. Taking forward the idea of the imaginary tribe Na'vi in the movie, a team of over a hundred scientists in Moscow is working on a project that can transplant the human brain and its personality related attributes into a machine. Once all the attributes of the human brain are mapped properly, our brains will be available in a soft copy form, ready to be downloaded and installed on a machine. And that could possibly mean that scientists could tap into the minds of iconic individuals and how their thought process went even long after they are gone.

On the same lines, IBM Research and five leading universities have partnered to create computing systems that are expected to simulate and emulate the brain's abilities for sensation, perception, action, interaction and cognition while rivalling its low power consumption and compact size. There have been other successes as well, in replicating the level of human intelligence by a machine. Based on the learnings from human brain mapping, a computer program named "Eugene", which was created by Vladimir Veselov of Raritan, New Jersey, has nearly passed the famous 'Turing test', which measures the ability of a machine to behave intelligently. The idea of the "Turing test" is pretty simple. A human judge engages in a natural language conversation with a human and a machine. All participants are separated from one another. If the judge cannot reliably tell the machine from the human, the machine is said to have passed the test. In more than 60 years of its history, no other machine has come this close to passing this test. So Eugene could prove to be the beginning of a giant leap forward.

A recent US government funded "Human Connectome Project" has developed a diffusion-imaging scanner, which works

by tracking the passage of water molecules through nerve fibers inside the brain to depict a more accurate picture of neurons as well as neural pathways. These pathways are then reconstructed through computer-based algorithms that explain the water diffusion and generate a much more precise image of the brain's circuitry. In the words of Van Wedeen, Director of Connectomics at the Martinos Center for Biomedical Imaging at Massachusetts General Hospital (MGH), "It's the difference between looking at the bonnet (of a car) and looking at the gears and belts inside." While initial expectations from the project are just to increase the accuracy of neuro-imaging to understand brain disorders like autism, schizophrenia *et al*, the future is left open for numerous other opportunities. The idea that Connectomics will be as fundamental to neuroscience as Genomics is to molecular biology, has gained momentum in a major portion of neuroscientist fraternity. But there are schools of thought, which go against it and argue that maps of the brain by themselves cannot offer much insight into how the brain performs its functions. Just as a genome by itself is only a raw map with little power to explain how an organism works, a connectome is at best a framework with little or capacity to explain the functionality of brain.

Going further, the existence of subtle energy and its conversion into substantial energy has been an exciting area of research for

years. Till recently, nothing concrete had come on this front. However, with advancements in brain mapping, scientists are in a position to draw images, which can very conclusively prove the existence of subtle energy. In a recent conversation with TechNext, Dr. Jeffrey Fannin from Center for Cognitive Enhancement, who is working with Rob Williams and an internationally known physicist who deals with subtle energy said, "We already have some very interesting preliminary results from our studies. This research, along with our previous research of identifying the whole-brain state, may turn out to be the gateway to utilizing the subtle energy in the quantum field to achieve higher states of consciousness."

With so many fields looking to benefit from advances in brain mapping, how can business stay behind? There is a totally dedicated stream in neuroscience named "neuro-marketing", which attempts to understand the chemical patterns in the human brain to predict buying behaviour. Once marketers understand why a consumer would prefer a certain product over the other, product specifications can be changed significantly based on customer wants. A March 2012 research authored by Carmen Nobel and published by Harvard Business School gives the instance of junk-food giant Frito-Lay, which hired a neuro-marketing firm in 2008 to look into how consumers respond to images or other stimuli related to Cheetos, the top-selling brand of cheese puffs in the United States. Using EEG technology on a group of consenting subjects, the firm determined that consumers respond strongly to the fact that eating Cheetos turns their fingers orange with residual cheese dust. With this information in hand, Frito-Lay moved ahead with an ad campaign in the US themed 'The Orange Underground', featuring a series of 30-second TV spots, in which the Cheetos mascot Chester Cheetah encourages consumers to commit subversive acts with Cheetos. During one such

CHEETOS REALISED THAT CONSUMERS REACTED STRONGLY TO THE RESIDUAL CHEESE DUST THAT TURNED THEIR HANDS ORANGE



Dr. Jeffrey Fannin during on of his brain training sessions that are done to alter human behaviour with specific end goals in mind

commercial, an airline passenger quietly sticks Cheetos up into the nostrils of a snoring seatmate. The campaign became a grand success, and even helped Frito-Lay grab a 2009 Grand Ogilvy Award from the Advertising Research Foundation.

This is not a one of its kind example. Companies are increasingly leveraging such studies in their market research and product development research projects. Daimler-Chrysler conducted a similar study to understand the effect of their cars on the consumer's mind. The study revealed that images of sports cars generate signals from the reward center of the brain; the same



While they facilitate marketers in measuring consumer responses, consumer grade EEG headsets are also considered a serious threat to individual privacy

THE FINDINGS OF BRAIN MAPPING TESTS CANNOT BE USED AS AN EVIDENCE IN THE COURTS IN INDIA

area, which gets hyperactive during the consumption of alcohol or drugs or during sex. Also, when respondents saw the front of the car, the portion of the brain that responds to face recognition lit up, suggesting some association with a person they knew. These are tremendous insights for a future car design. Another research offered Coca Cola and Pepsi to the participants. When they did not know what they were drinking, researchers could see the sensory aspect of the brain get active. But once they knew the brands, the emotional part got active as well and the preference shifted to Coca Cola (*no wonder it remains the bigger brand*). While opinion poll surveys, focus groups and other such related tools suffer from the problem of biased responses, brain mapping-based neuro-marketing can be the answer to the challenge.

Admittedly, despite all the recent advancements in this field, there is still a long way to go. While the latest imaging techniques are assisting medical practitioners to give a new lease of life to millions of patients, the use of brain mapping in other areas has yet to produce results that are precise enough to significantly impact human lives. Moreover, results deduced from various brain mapping attempts have yet to achieve a universal recognition. While these are widely used for medical purposes, not many countries recognize the results of these tests for legal purposes,

or even for the market research applications just discussed. Previously, in a lot of cases in India, the courts have given permission for brain mapping tests of convicts but still, the findings of these tests can't be admitted as evidence in the courts. But over time, depending on the rate at which results of such tests get validation, these issues should get resolved. Neuro-marketing itself faces challenges, albeit of a different hue. There are potent consumer groups in US and in the rest of the world, which believe that such attempts invade a consumer's privacy and can also manipulate his natural buying behaviour. But then, isn't that what 'marketing' is all about? In that sense, this kind of activism is actually pointing a finger at marketing in general, and where can (*or should*) the line be drawn.

In fact, there can be more dangerous consequences than that. The biggest threat is to our privacy. A recent research paper titled, "On the Feasibility of Side-Channel Attacks with Brain Computer Interfaces," uncovers potential security risks in the use of the consumer-grade EEG headsets. In this paper, a team of security researchers from Oxford, UC Berkeley and the University of Geneva have claimed that they were able to deduce digits of PIN numbers, birth months, areas of residence and other personal information from 30 subjects who were wearing consumer-grade EEG headsets and who were exposed to images of ATM machines, debit cards, maps, people and random numbers in a series of experiments. Critics and researchers are even concerned about a scenario where a potential malicious attacker could write "brain spyware" program, which can extract private information from the user, which could be legitimately downloaded as an app. As imaging technologies progress and get coupled with powerful & futuristic softwares, threats will be bigger. Since it's a field that scientists are only beginning to understand, they'll have to be especially careful that sensitive information & technology doesn't reach the wrong hands. 



"I DON'T THINK BRAIN MAPPING WILL BECOME A REPLACEMENT"

Dr. Jeffrey Fannin, Founder & Executive Director, Center for Cognitive Enhancement, USA

Dr. Fannin has been engaged in brain mapping and brain training for over 15 years. In particular, he has been studying the neuroscience of leadership since 2003. In November last year, he co-authored an article with Rob Williams for the neuroscience community in a special edition of Neuro Connections focusing on the neuroscience of leadership. He discusses some of his findings here with Ashish Kumar of TechNext:

TN: CAN BRAIN MAPPING BECOME A REPLACEMENT FOR JUDGEMENT, WHILE ANALYZING THE SKILLS AND POTENTIAL OF A HUMAN BEING?

DR. JEFFREY FANNIN (JF): I don't believe that brain mapping will become a replacement. It will be more like a tool – using the brain map to guide the training areas of the brain that are known to be linked to leadership.

TN: IF WE SOMEHOW GET TO COMPLETELY UNDERSTAND ALL THE NEUROLOGICAL COMBINATIONS THAT MAKE HUMANS BEHAVE IN A CERTAIN WAY, CAN WE ALTER THOSE COMBINATIONS? HOW DISTANT IS THIS POSSIBILITY IN YOUR VIEW?

JF: This does not sound distant at all. We are doing it now. My colleagues Rob Williams and Dr. Bruce Lipton, the well-known author of "The Biology of Belief" and myself have put together a program for working with leaders and balancing subconscious belief patterns with the Principles of Nature to achieve sustainable success. Some of our research in the past two years has involved subconscious belief patterns. Changing subconscious beliefs will alter behaviour as has been pointed out in our articles.

TN: WHAT HAVE BEEN YOUR MOST IN-

TERESTING EXPERIENCES DURING YOUR EXPERIMENTS WITH BRAIN MAPPING?

JF: The process of brain mapping never ceases to amaze me. Even after doing it for over 15 years, I still marvel at the brain's ability to do such amazing things. I have worked with children having trouble in school and with adolescents who were able to turn their life around due to brain training, or brain tuning as we like to call it. I have seen amazing things happen with adults, leaders and non-leaders alike. We have only scratched the surface as far as brain mapping, brain tuning and achieving higher levels of consciousness are concerned.

TN: BRAIN TRAINING IS A CRITICAL PART OF YOUR RESEARCH WORK. HOW DO YOU HANDLE THE CASES THAT COME TO YOU?

JF: The value of brain mapping is knowing where an individual can train his/her brain for optimal performance, whether you are an athlete, a leader or a student trying to achieve better academic performance. I have many cases where we measured IQ performance, trained the brain and improved the efficiency of the brain to have a higher measured IQ. It's not that the IQ is increasing; the brain's ability to process more efficiently creates better connectivity in the brain and the potential IQ measures higher; it also performs better.

TN: WHAT OTHER WONDERFUL OPPORTUNITIES DO YOU SEE FOR "BRAIN MAPPING" IN FUTURE?

JF: I am currently doing some interesting research with my colleague Rob Williams and an internationally known physicist that deals with subtle energy and how it affects the brain. We already have some very interesting preliminary results. This research, along with our previous research of identifying the whole-brain state, may turn out to be the gateway to utilizing the subtle energy in the quantum field to achieve higher states of consciousness. Stay tuned for that! 