# Neuroscience Reveals the Mind/Brain Interface and How It Controls Our Behaviors and Our Lives

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## ABSTRACT

One hundred twenty-five cases were examined, data was collected over a 12 month period, in three different locations, with different EEG technicians, using two different types of EEG equipment; showing the p-value is <=0.010. This paper presents research that clearly links the mind/brain interface. It also provides insight into how subconscious belief patterns affect our behaviors and control the outcome of those behaviors in our life. This kind of research might well be very important and useful providing a greater understanding of how to implement processes oriented toward integrating thought and behavior patterns in all areas of our life. The creation of the essential neuropathways, indicated by the author, most certainly will help in processes oriented to integrate three main components: (1) research, (2) education and (3) consulting. The process is key to improving the performance of each of these three activities.

**Keywords:** QEEG, Quantum, Brain Mapping, PSYCH-K®, Thought, Subconscious, Belief Patterns

## 1. INTRODUCTION

We have explored the mind/body conundrum since man first became aware of his own existence. We have pondered concepts like the *mind, consciousness, thought, intelligence* and *awareness* in an effort to begin to define the relationship between the mind and body. We believe that by defining such words we will come to an understanding of what is happening in the *process,* and/or the *experience*. Down through the ages the questions of the human mind's consciousness seem to create problems that we try to explain away. Harvard cognitive scientist Steven Pinker commented on consciousness. *Although neither problem has been solved, neuroscientists agree on many features of both of them, and the feature they find least controversial is the one that many people outside the field find the most shocking. Francis Crick called it, "the astonishing hypothesis" – the idea that our thoughts, sensations, joys and aches consist entirely of physiological activity in the tissues of the brain. Consciousness does not reside in an ethereal soul that uses the brain like a PDA (personal digital assistant); consciousness is the activity of the brain* [1].

Prevailing hypothesis posits that the brain is the seat of consciousness. Further more, the brain actively is a self-emergent property of the brain itself. This paper challenges this hypothesis, and argues that which we call the mind is separate from the brain and is the true origin of brain activity. This conclusion is evidenced by the emerging field of epigenetics.

Our journey should begin by understanding the anatomical and functional process of consciousness. We begin our understanding by distinguishing between the *operation of consciousness* and the *content of consciousness* [2]. The *general operation of consciousness* (GOC) is characterized by longer time intervals and relatively time invariant processes such as sleep, wakefulness, arousal, and coma. The GOC is a relatively tonic state, with slow adjustments of the levels of arousal (i.e., on the order of minutes and hours), such as changes in levels of awareness and/or drowsiness and are mediated by reticular-limbic and thalamic excitatory control systems. In contrast, the *content of consciousness* (COQ) is defined as the momentary collection of sensations and thoughts that we would call the "present moment," which is temporally and hierarchically nested within the GOC and is mediated by the coherent activation of large ensembles of neurons.

William James referred to the content of consciousness as the *specious present*, which he defined as that "interval of time (about 1 to 7 seconds) when an event that belonged to the present is distinctly perceived as the past" [3]. A finer temporal grain of the content of consciousness is provided by the psychophysical experiments of Efron [4], [4a] that demonstrated an approximately 20- to 200-ms *perceptual frame* in which nearly simultaneous events were integrated into a perceptual whole event [5], [5a].

This work was reviewed and summarized in a publication entitled, *Functional Landscapes of the Brain: An Electrotopographic Perspective*, in which the results of

both spatial principal components analysis (SPCA) and temporal principal component analyses with Varimax rotation (TPCVA) analyses were presented in a series of experiments [6], [6a]. Grossberg and Somers did mathematical and simulation studies by demonstrating that zero phase locking between connected networks occurs whenever two conditions are met: (a) there is strong coupling and (b) there is some form of delay (or inhibition) involved in the coupling between networks [7]. Other studies have postulated a specific role of feedback and feedforward inhibition in the creation of synchronized zero phase locked neural activity [8] [8a]. Thus, strong coupling and delays appear to be necessary. Studies completed at the National Institutes of Health involved the neuronal mechanisms by which human voluntary movements occur using multimodal registration of EEG, MRI, and PET. EEG coherence and phase measures were obtained, before and after finger movements, and specific patterns of neuronal activation were observed to correlate with the allocation of resources that underlay the finger movements. A neural network switching model was developed in which loops of cells behaved similar to spinning tops or gyroscopes. The justification for this view was standard neural network models that involve nearly instantaneous switching dynamics that could not explain the computation of strong second derivatives involved in the dynamics of neuronal switching, and essential elements in the establishment of zero phase lag coherent neural activity. However, precisely which brain regions (e.g., thalamus, reticular formation, limbic cortex, etc) control the spatial and temporal distribution of inhibitory and excitatory drives at a given moment of time, is very complicated, and likely task specific [9] [9a].

Many scientific perspectives consider consciousness to be the result of sensory input brought into the brain by different sensory afferents; the very function becomes the basis for cognition [10]. Some have looked at cognition as an intrinsic functional state of the brain. It has been proposed that consciousness is an oneiric-like internal functional state modulated, rather than generated by the senses [10a]. As a child we may remember the sound of a curtain fluttering in the dark and how it could evoke worrisome images that were immediately dispelled when the lights were turned on. Understanding that the internal events we perceive as *thinking, imagining* or *remembering* are related to an intrinsic activity. A large percentage of the connectivity in the brain is recurrent and that much of its activity is related to intrinsic connectivity not necessarily related to the immediacy of sensory input.

We are aware that when we are very tired, we fall asleep very quickly, and while asleep an extraordinarly strong stimulus is given us (i.e. an alarm clock), we can then awaken remarkably fast. Understanding that the substrate capable of supporting the speed of these two events must be electrical in nature, in the sense of the electrical activity of neurons and the synaptic input that initiate or terminate such activity. This would prompt the question, what is the basic difference between being awake and being asleep? The answer to this question would provide the fundamental clues as to the nature of consciousness.

Being asleep does not support the feeling of self-existence. We might also equate consciousness with cortical function almost on an exclusive basis. One additional assumption related to consciousness is that it is a global function state of the brain relating to more cortical activity. Perhaps the energy measured in the brain relating to consciousness and the creation of a unified brain function may be both resonant, and have properties of oscillation.

## 2. THALAMOCORTICAL GAMMA-BAND RESONANT COLUMNS

In recent years, studies have shown that coherent electrical activity in the cortex is relevant to the function of resonance when considering its relationship to cognitive thought [11]. This work proposed that coherent events occur at the cortical level, and such cortical events are the primary binding substrate [12]. Other experimental results illustrate that the *binding event* must not be cortical but rather thalamocortical [13]. The use of magnetoencephalography (MEG) in humans and extracellular and intracellular recordings in cats *in vivo,* indicate that such activity is supported by resonance between thalamic and cortical structures at gamma-band frequencies (i.e. with frequencies between 20 and 50 Hz), and are often centered close to 40 Hz [14]. The results of this study favored the hypothesis that cognitive events depend on activity involving thalamocortical resonant columns. These neuronal mechanisms are responsible for high-frequency thalamic oscillations that support the synchronization of thalamocortical structures and their relationship to coherence.

## 3. OSCILATORY PROPERTIES OF THALAMIC CELLS

Nearly twenty years ago it was suggested that there is an intrinsic neuronal element with the oscillatory or resonant properties related to a neuronal network that facilitates the occurrence of coherence between interconnected elements [15]. Llinas explains that the intrinsic electrical properties of thalamic neurons support high-frequency (20-50 Hz) subthreshold oscillations when thalamic neurons are depolarized beyond -45mV [16]. Previous studies *in vivo* describe oscillations in both relay and reticular thalamic neurons [17]. Understanding the basis of the dendrite conductance is a key issue for the effect of fast oscillation in thalamocortical cells. They depend on

the activation of voltage-dependent calcium conductance [18]. This demonstrates that neurons exhibit active membrane oscillations and are part of intrinsic oscillation properties of the thalamic cells. These findings are in accordance with previous work reporting that thalamic cells display highly rhythmic activity in the gamma range of frequencies [19].

Active dendritic oscillations are functionally significant, in that they return input from the cortex to thalamic neurons providing a unique opportunity for resonance between intrinsic dendritic oscillation and rhythmic synaptic inputs [20]. We can conclude from this that coherence of fast rhythms in thalamocortical loops might depend on the patterns of synaptic inputs and on the responsive state of the neurons.

When considering the neuronal circuit oscillating in the Gamma band (40-60 Hz), the neurons in specific thalamic nuclei establish cortical resonance by direct activation of pyramidal cells and feedforward inhibition through the activation of 40 Hz inhibitory interneurons in layer IV. These oscillations re-enter the thalamus via layer VI pyramidal cell axon collaterals, producing thalamic feedback inhibition via the reticular nucleus [21]. In layer V, pyramidal cells return oscillations to the interthalaminar nuclei in the gamma-band and are capable of recursive activation [22]. It is understood that neither of these two circuits alone can generate cognition. This would offer the notion that there is a specific organization of the thalamocortical system that when it receives special input activity, resonation occurs. After optimal activation occurs in the thalamocortical loop, then oscillation in the gamma-band is easily recognized over the cortex by its oscillation characteristics. Thereby, causing the sites to peak and become a cognitive component that is capable of optimal activity.

The body of work preceding this study suggests that there are several different rhythmic and oscillatory functions that travel between the thalamus and the cortex. They function on the basis of temporal coherence and the simultaneity of neuronal firing. In turn, the neuronal firing is based on the passive and active dendritic conduction, and would provide a mechanism for global binding. Such a system would provide the content that relates to the external world, and the non-specific system would give rise to a context that is more concerned with alertness. Together they would generate a single cognitive experience [23].

## 4. THE ISSUE OF ZERO PHASE LOCKING

E. Roy John presents information related to zero phase locking of coherent neural activity during perception and memory that is of great significance to understanding the brain's ability to provide for optimal performance, and what I would characterize as the whole-brain state [24]. What is especially unique and important is the finding of five spatial principal components (SPCs) capable of accounting for 90% of the variance of scalp voltage patterns that reflect coherent activation of large ensembles of neurons. The fact that the SPCs were similar during different cognitive tasks and in different subjects suggests fundamental subsets of organized neural resources that are common to all people performing these tasks. This suggests further that these SPCs reflect a binding process that brings together spatially distributed fragments of the past to evaluate and experience the immediate present in a brain state [25].

Oschman says that atoms are measured by their vibration, while in constant motion. They create wave patterns similar to the expanding ripples from pebbles thrown into a pool of water. Each atom is unique because the distribution of its negative and positive charges coupled with its spin rate, generates a specific frequency pattern [26]. Bruce H. Lipton adds an important point to the phase locking issue with consideration of *destructive* and *constructive interference patterns*. He explains that the behavior of energy waves is important in biomedicine because vibrational frequencies can alter the physical and chemical properties of an atom. An example of *destructive interference* would be when a pebble is dropped into water and the waves are moving outward from the center. Shortly after the first pebble is dropped, a second pebble is dropped. Since the pebbles do not hit the water at the same time, the waves will not be aligned; they will be out-of-phase. *Constructive interference* would be similar except that when the second pebble hits the water, the ripples moving outward are in-phase and come together to create higher amplitude of the composite wave. Lipton explains when you want to enhance, rather than stop atoms, you find a vibration that creates harmonic resonance [27].

## 5. THE COHERENT VIBRATIONS OF THE AXONS' GLYCOCALYXES

Axons have a repeating structure, spaced at fixed intervals, and specifically designed to amplify the signal from the thalamus by activating the gate-channel complex, embedded in the axon's membrane. One particular membrane structure that should give rise to coherent energy waves is the glycocalyx, or sugar coating, which is composed largely of glycoproteins, or proteoglycans. These include a number of derivatives of chondroitin sulfate and heparan sulfate. All of these structures are inside the myelin sheath of each axon. Glycoproteins have an uncharged protein end, which dissolves in the fatty membrane, and a very negatively charged sugar end, which sticks out into the external fluid, somewhat like a ball on a rubber stick [28]. Jonathan D. Cowan explains that together, these sugars form the bulk of the glycocalyx. There is a gate/channel complex that changes conformation to briefly allow ions

into the axon during a nerve impulse, thus causing the nerve cell to depolarize. It then returns to its original shape when the impulse has passed. When this gate/channel complex in the membrane moves rapidly in response to a nerve impulse, the charged sugar ends, that line the axonal membrane, should all vibrate back and forth. These glycoproteins are either directly or indirectly connected to the channel protein. As the channel opens and then closes in response to each impulse, its kinetic energy is transferred to the glycoprotein and to other surrounding structures, which vibrate and emit an electromagnetic wave, until this motion is damped out. Other vibrational modes and frequencies as well as the related electromagnetic waves, result from the movements of charged atoms within the membranes. Lipton says this is roughly analogous to what happens every time we open, then slam a door shut. Some of the kinetic energy is transferred to the surrounding walls, where it vibrates their internal layers, as well as the surface structures [29]. External energy oscillations will undoubtedly affect the structures, combining to create a condition that is both subject to resonation and oscillation, resulting in the creating of a unified whole-brain state.

## 6. THE ZERO-POINT FIELD AND ENTANGLEMENT

For centuries, the Newtonian perspective that the universe was mechanistic and things work in a comfortable and predictable manner has long been replaced by quantum theories. We understood that subatomic particles were not solid little objects like billiard balls; Einstein taught us that they are vibrating packets of energy that sometimes acted like a particle and sometimes like a wave. Heisenberg presented the notion that quantum particles are *omnipresent.* Quantum physicists discovered a strange property in the subatomic world called *nonlocality* to describe the properties of what we now call quantum entanglement. This refers to a quantum entity such as an individual electron influencing another quantum particle instantaneously, over any distance, despite there being no exchange of force or energy. It also suggested that quantum particles once in contact, retain a connection even when separated, so that the actions of one will always influence the other, no matter how far they are separated [30].

Pribram presented ideas that the mind and consciousness are not just local events. Rather, they exist as part of a constantly changing fundamental field that he termed the *biofield* [31]. Noted physicist David Bohm based his analysis of the nonlocal field on empirical evidence of quantum theory [32]. Pribram agreed with Bohm's idea that there is an *implicate order* to the universe that pertains to all matter. As it pertains to brainwave activity he proposed that there are holonomic overlapping patches of holographic structures in the cortical surface layers of the brain, which would transform inputs from perception and thoughts into slow electrical potentials presented in EEG brain wave patterns. Bohm also suggested that several different types of fields, each operating at many spatial and temporal frequencies, may well be involved. He said that the characteristics of the particular type of *oscillation* would partially determine the range and resolution of the potential information transfer; this has yet to be understood. Quantum fields do not diminish as quickly over distance as electromagnetic fields do in the brain [33].

## 7. INTRODUCTION TO QUANTUM EFFECTIVENESS

While quantum correlations, or entanglement, are clearly of paramount importance for efficient pure state manipulations, mixed states present a much richer arena and reveal a more subtle interplay between correlations and how to distinguish between them [34].

We do not generally understand why events we observe around us are correlated in the first place. Correlations themselves are very simply quantified within the framework of Shannon's information theory. Suppose we repeatedly perform measurements on a given system, at different instants of time. Let us record the outcomes of our observations as a sequence. Different sequences of outcomes will naturally have different probabilities associated with them.

Correlations now suggest that this probability will most generally not be expressible as a product of probabilities of subsequences. Shannon introduced the notion of mutual information in order to quantify how correlated different observations are [35].

For simplicity, if we divide measurements into two groups, A and B, each of them having a well defined probability distribution, respectively, as well as a joint probability distribution, then the mutual information between A and B is defined. This is the well-known Shannon entropy model. There is a certain degree of subtlety in trying to extend Shannon's mutual information to more than two different sets of outcomes (A and/or B). The concept of mutual information is so general that it can easily be extended to quantum systems [36]. This leads us to understand that having of quantum mutual information, which, for a general state of either A and/or B is now defined and provides the basis by which the relationship can be understood.

First of all there is entanglement. Given a bipartite quantum state (where there are two separate entities with substrates), entanglement by the states of the form are known as separable or disentangled. Entanglement is then

most easily quantified by calculating how different this state is to any separable state. This will simply mean that there is a state for system A and a separate state for system B. Shannon says, the more correlated A and B, the more we can learn about one of them by measuring the other. Suppose we make measurements of A. For each measurement there is an outcome occurring with probability. We can also define this quantity by swapping the roles of A and B. It is true that separate states contain correlations over and above just the classical ones. The discrepancy between the two is known as the quantum discord. We will call discord the correlations over and above classical brain states but excluding entanglement [37]. The general picture is this, quantum mutual information in any quantum state, A or B, can be written as a numeric value of entanglement in the state as measured by the relative entropy of entanglement [38] to put it on an equal footing with other entropic measures of correlations. Physically this means that the quantum mutual information measures total correlation in a quantum state.

We might ask, what feature of quantum mechanics makes quantum information processing more efficient than classical resonation? *It has been said that quantum entanglement is clearly that feature.* The answer seems obvious in the case of pure states. If there is no entanglement during the evolution of pure states, then that evolution can efficiently be simulated by classical systems [39]. But, we should remember that according to our above discussion, pure states contain the same number of classical correlations as entanglement. Therefore, we might well say that it is classical correlations of resonance in pure brain states that are responsible for the speed-up. And that, the oscillations from entanglement create the quantum effectiveness, which leads to the unified whole-brain state, which in turn can now operate with complete balance and efficiency in all areas, adding to a heightened level of consciousness and cognitive ability.

## 8. DISCUSSION OF THE WHOLE-BRAIN STATE'S EFFECT ON OUR BELIEF SYSTEM

A controlling factor in human interactions seems to be the whole-brain (hemispherically synchronized) state. A study reported in 1988 in the *International Journal of Neuroscience*, by researchers at the Universidad Nacional Autonoma de Mexico, suggest that synchronized brain states significantly influence nonverbal communication. The study was done with thirteen paired subjects. The subjects were tested in a darkened and soundproof Faraday cage (a lead-lined screened chamber that filters out all outside electromagnetic activity). Each pair of subjects was instructed to close their eyes and try to "communicate" by becoming aware of the other's presence and to signal the experimenter when they felt it had occurred. The brainwave states of the subjects were monitored during this process. Experimenters reported that during the sessions an increase in similarity of EEG (brainwave) patterns between the pairs of communicators developed. Furthermore, the experimenters noticed, "The subject with the highest concordance [hemispheric integration] was the one who most influenced the session." In other words, the EEG patterns of the individual with less synchrony between the brain hemispheres would come to resemble the EEG pattern of the person whose two sides more closely resembled each other [40].

These conclusions support the allegation that our thoughts, even nonverbally expressed, can influence others. In fact, the more whole-brained *we* become, the more we influence *others* toward that state of being as well.

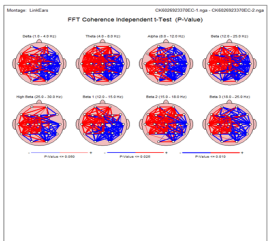
In Dr. Bruce H. Lipton's bestseller, *The Biology of Belief*, he says, "*Our positive and negative beliefs not only impact our health, but also every aspect of our life.*" He goes on to say, "*Your beliefs act like filters on a camera, changing how you see the world. And your biology adapts to those beliefs*." [41]
Robert M. Williams M.A., originator of PSYCH-K®, explains the significance of subconscious belief patterns. Our beliefs, usually subconscious, are the cumulative effect of life-long "programming." As a result of past conditioning, we sometimes think and behave in self-defeating ways. Conscious thoughts can be changed easily by simply receiving information: reading a book, having a conversation, or seeing the results of actions. However, if conscious information were all that was needed to lead satisfying and successful lives, most of us would already be doing that. Unless changes are made at the subconscious level, however, repeating undesired reactions and behaviors will likely continue. Subconscious beliefs have far reaching consequences, both positive and negative, in every aspect of life. They affect our moods, relationships, job performance, self-esteem, and even physical health. It is imperative to know how to change self- limiting beliefs into self-enhancing beliefs that support our goals and aspirations. Williams explains, "*PSYCH-K® is a mind/body interface process that gives us control over the detrimental effects of past experiences, freeing us from those habitual reactive behaviors that no longer serve us.* " [42].

## 9. QEEG AND QUANTUM EFFECTIVENESS

Our research gathering documented one hundred twenty-five (125) cases, with data gathered over 12 months in three different locations, utilizing different EEG technicians, using two different types of EEG equipment; the result of this investigation produced a p-value of <=0.010.

A baseline of EEG data was established for each case. Using EEG caps calibrated by Electro-Cap International, standard procedure was to inject each of the 10-20 international systems for electrode placement with standard electro-gel making contact with the scalp and the electrode. Ensuring that the dc-offset voltages were within acceptable range, three (3) baseline readings of five (5) minutes each was recorded; five minutes eyes open, five minutes eyes closed and five minutes with the brain on task (reading silently in a magazine).

A Certified PSYCH-K Facilitator, used standard PSYCH-K® practices to achieve the whole-brain state with the subject. Following the intervention of the PSYCH-K® change process (aka a *balance*), a post-intervention EEG was recorded in the same manner as the EEG baseline stated above. The *balance* took approximately 10 minutes to complete. Raw EEG data was artifacted to eliminate eye movement, tongue movement, swallowing or other unwanted disturbances in the EEG. Standard EEG artifacting criteria was used and accomplished by an experienced qualified EEG technician. A minimum of 1 minute of artifacted *clean* data (although data presenting at .90 or above is considered acceptable; standards for artifacted data for this study must meet or exceed .95 in both *Split-Half* examination and on *Test-Retest* examination). Statistical analysis was performed by NeuroStat, a function of the NeuroGuide program from Applied Neuroscience. NeuroStat allows for individual independent t-tests to be performed. The following are several examples from the base of 125 cases examined for the whole-brain state.

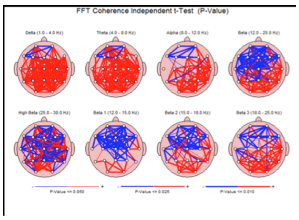



The independent t-test compares condition A to condition B and shows if there are differences in the dominant brain function (consider the discussion of Shannon's method above).

In all of the depictions shown here the legend is the same. The RED represents the dominant brainwave pattern prior to the facilitation of the PSYCH-K® *balance*. The BLUE represents the dominant brainwave pattern after the energy balance had been facilitated. The thickness of the line, indicates level of P-factor, see legend below figures.

The whole-brain state is considered to be the combination of RED; condition A, dominance prior to energy balance. And condition B, dominance after the energy balance was facilitated.

Due to the space restriction of this paper, it is not possible to provide a comprehensive treatment of this subject. However, the amount of data collected, and the unique properties it represents, afford us the opportunity to evaluate and continue to understand what it means, as well as providing intriguing hints the nature of its potential.




## 10. CONCLUSION

Clearly there is more to learn and understand in this robust field of study. More scientific papers are forthcoming to better identify the nature and results of this work, as well as its relationship to neuroscience. A greater understanding of the relationship between the oscillation of the zero-point field and brainwave resonation is an area for continued research. In addition, more research needs to be done to discover the significance of thought and it's effect on subconscious belief patterns. Clearly, subconscious belief patterns guide our perception and behavior. Knowing how changing perception at the subconscious level of the mind, can change a subconscious belief pattern, can now be depicted in brainwave energy and the creation of the whole-brain state. Continued research in this area will assist in recognizing and adopting applications that will be beneficial in academics, personal health, professional performance, and virtually every area of human life. Practical applications of changing subconscious belief patterns have existed for over two decades; today we can measure them and graphically demonstrate their efficacy, lending to further understanding and utilization of this important aspect of human existence in virtually all walks of life.

"*A human being is a part of the whole, called by us 'Universe,' a part limited in time and space. He experiences himself, his thoughts, and feelings as something separated from the rest, a kind of optical delusion of his consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and to affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty. Nobody is able to achieve this completely, but the striving for such achievement is in itself a part of the liberation and a foundation for inner security.*"

***–Albert Einstein-***

**Only now we are beginning to understand!** -JLF-

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# *VALUE OF BRAIN TRAINING IN SPORTS*

By
Dr. Jeffrey L. Fannin, Ph.D.

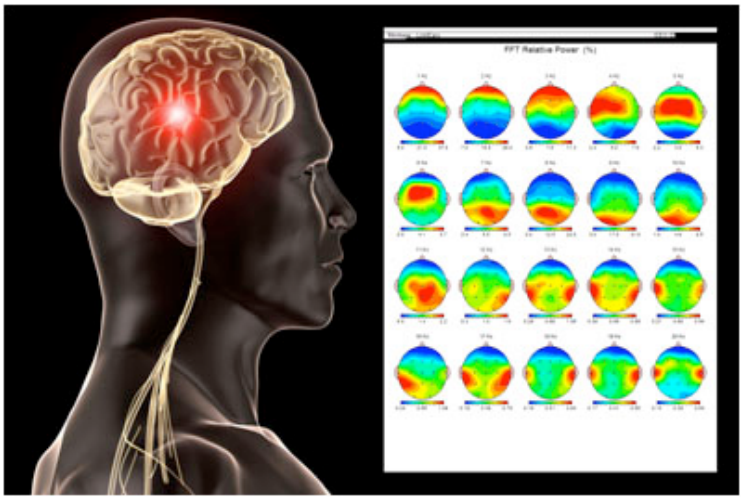
In sports, training and physical "readiness" are essential. Being prepared to play physically at a very high competitive level can be everything. It is commonly understood in athletics that a healthy mind state can give a competitive athlete the edge needed for an outstanding performance. Sometimes that is easier said than done. Thoughts of doubt, stress and concerns about failure during competition in an athlete's mind can have a devastating effect on performance. It is because of these thoughts that athletes perform well during training and practices but buckle under the pressure of competition. Why do athletes experience this *performance anxiety*? Why don't years of training instill the confidence and control needed to achieve excellence?

Basically, there are two major reasons: (1) the brain itself is not performing at optimal levels and (2) the subconscious belief patterns that guide our behavior are misaligned. The brain is the most complex organ in the universe; neuroscience is only now coming to understand the fundamentals of how it works and how to train it to achieve sustainable success and optimal performance.

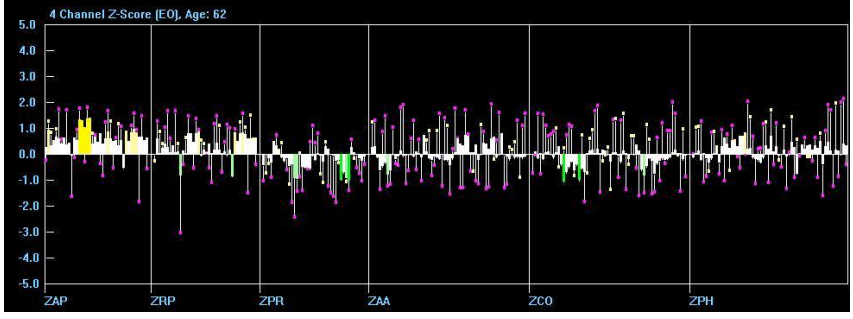
As founder and executive director for the Center for Cognitive Enhancement, I have been training the brain for optimal performance, improving focus and concentration, as well as emotional and intellectual dexterity for nearly 15 years and continue to be on the cutting edge of brain science and brain training. From about 2006-2010, I participated as part of a research team at Arizona State University. I was involved in research that allowed our team to analyze both seasoned combat officers and cadets at the United States Military Academy at West Point. There, we examined brain patterns that involved complexity of thinking and issues related to *extremous leadership*. This is a condition that creates the brain patterns that allow a person to exhibit leadership and possess the ability to perform under the extreme conditions that often occur on the battlefield. This is the same brain function that allows a first responder to charge into a burning building and keep command of his faculties under extreme stress. Of course an athlete is not required to put their life on the line every time they compete, but the patterns of brain activity to perform at the highest level are still the same.

Not long ago we worked with a high-profile professional hockey player; he was hit by a puck in the face. After recovering from the physical injury his ability to perform at his previous level was no longer there in any consistent form. He was now in danger of being traded or cut from the team. After receiving a QEEG brainmap and balancing of the subconscious belief patterns around the injury and his performance, not only did he return to his prior ability but went beyond what he was previously capable of doing. He is now scoring more goals than his previous performance, his skating speed is faster and his ability to know where other players are on the ice has helped him create more assists than ever before. The question becomes, "how did that happen?"

The first part of the process is to evaluate the electrical patterns in the brain. We need to know if the neurons are firing correctly in order to create the right connections and also if they are firing efficiently enough to achieve the desired result? To make a proper assessment we use a non-invasive procedure known as an *electroencephalogram* (EEG). This process allows us to measure the electrical impulses of the brain under different conditions such as eyes open, eyes closed and with the brain on task. The information is then processed and converted to a *quantitative electroencephalogram* (QEEG), a partial report shown to the right.



| | T3-T4: | | | T3-T5: | | | T3-T6: | | | T4-T5: | | | T4-T6: | | | T5-T6: | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ASY | COH | PHA | ASY | COH | PHA | ASY | COH | PHA | ASY | COH | PHA | ASY | COH | PHA | ASY | COH | PHA |
| Delta (1.0-4.0) | 0.2 | -0.0 | -0.1 | -0.1 | 0.3 | -0.4 | 0.7 | -0.7 | 0.8 | -0.4 | -0.3 | 0.7 | 0.3 | 0.4 | -0.8 | 0.8 | -0.2 | -0.4 |
| Theta (4.0-8.0) | 0.3 | 0.1 | 0.0 | 0.1 | -0.4 | 0.3 | 0.1 | 0.0 | 0.2 | -0.2 | 0.0 | 0.1 | -0.2 | 0.1 | 0.0 | -0.1 | -0.3 | 0.3 |
| Alpha (8.0-12.0) | -0.1 | -0.2 | 0.1 | -0.1 | -1.1 | 0.6 | -0.2 | 0.1 | 0.2 | 0.1 | 0.0 | 0.3 | -0.0 | -0.6 | 0.3 | -0.1 | -0.2 | 0.4 |
| Beta (12.0-25.0) | -0.7 | 0.0 | -0.2 | -0.1 | -0.7 | 0.4 | -0.3 | 0.1 | -0.2 | 0.6 | -0.1 | -0.1 | 0.4 | -0.8 | 0.2 | -0.2 | -0.1 | 0.1 |
| Beta 1 (12.0-15.0) | -0.4 | 0.1 | -0.2 | -0.0 | -0.3 | 0.5 | -0.1 | 0.2 | -0.3 | 0.3 | 0.1 | 0.2 | 0.2 | -0.2 | 0.4 | -0.2 | 0.2 | 0.2 |
| Beta 2 (15.0-18.0) | -0.8 | 0.1 | -0.3 | -0.1 | -0.6 | 0.4 | -0.2 | 0.0 | -0.3 | 0.7 | 0.0 | -0.1 | 0.6 | -0.3 | 0.2 | -0.1 | 0.0 | 0.1 |
| Beta 3 (18.0-25.0) | -0.6 | -0.0 | -0.2 | 0.1 | -0.4 | 0.3 | -0.0 | 0.1 | -0.2 | 0.7 | -0.2 | -0.0 | 0.6 | -0.8 | 0.3 | -0.1 | 0.0 | -0.0 |
| Hi Beta (25.0-30.0) | -0.5 | -0.2 | 0.0 | -0.0 | -0.5 | 0.2 | -0.1 | 0.0 | -0.2 | 0.4 | -0.3 | -0.0 | 0.4 | -0.5 | 0.3 | -0.1 | 0.0 | -0.0 |
| Alpha 1 (8.0-10.0) | -0.0 | -0.2 | 0.0 | 0.0 | -1.0 | 0.7 | -0.2 | 0.1 | 0.3 | 0.0 | -0.0 | 0.5 | -0.1 | -0.4 | 0.2 | -0.2 | -0.2 | 0.4 |
| Alpha 2 (10.0-12.0) | -0.2 | 0.0 | 0.2 | -0.1 | -0.6 | 0.6 | -0.3 | -0.0 | 0.2 | 0.0 | -0.0 | 0.2 | -0.0 | -0.3 | 0.5 | -0.1 | -0.1 | 0.3 |




The cutting edge technology we use at the Center for Cognitive Enhancement examines the ability of the neurons to perform at optimal levels. The partial depiction (seen left) allows us to understand how well the neurons are firing throughout the different frequency bands in the brain. It is possible for this technology to measure and affect up to 9000 variables in the brain at one time. As seen here, it is possible to examine how well the neurons are performing in real time. It is also possible to determine which neurons are shutting down or are stuck in a loop, thereby reducing the brain's ability to perform at optimal levels when called upon to do so.

The condition of neuronal performance is only part of the equation, the subconscious patterning of the thought process is also vital to achieving optimal performance. Neuroscience has documented that 95% of what we

think, say and do is guided by our subconscious. Only 5% of our thought and behavior is accounted for by conscious thinking.

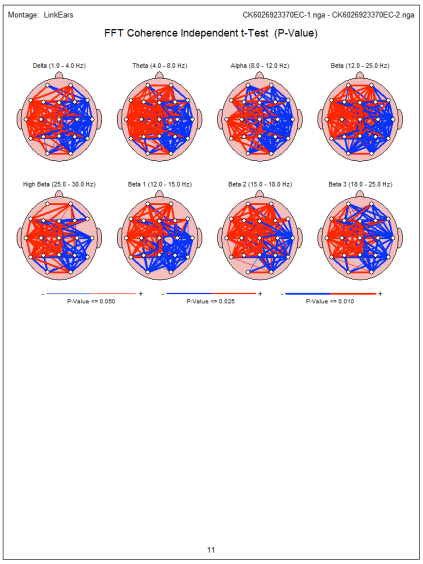
Conscious thoughts can be changed easily by simply receiving and focusing on new information such as reading a book, having a conversation with a coach, or seeing and understanding the result of one's actions. If conscious information was all that was needed to perform better and achieve sustainable success, then experiencing success in all areas of life would be easy. Unless changes are made at the subconscious level repeating undesired reactions and behaviors will surely continue.

*Sustainable Success* comes from understanding and knowing how to deal with brainwave patterns AND our ability to deal with our subconscious belief patterns or the rules that dictate our behavior; whether it is in life or in athletics, it is the same! The subconscious belief patterns are rules that have a cumulative effect and may not become present until certain conditions occur that triggers a particular subconscious rule. Because it is subconscious, we usually are not aware of what it is or where it came from. Subconscious belief patterning is a life-long proposition. It becomes most apparent when an athlete falls into a "slump." Nearly all athletes are subject to this phenomenon at one time or another. When that happens it is usually said about an athlete, "they need to get their confidence back." Hold on a minute here…I think what is really more accurate to say is that the neurons are in a condition of reduced neuro-plasticity or locked in a neuronal loop and subconscious patterning has taken over to produce a condition that results in a reduction of optimal performance on the field.

Ok, it is easier to say that *they need to get their confidence back*. The real point to all this is that is that we now have a way to measure and correct the condition. Neuroscience is being given an upper hand to previous thinking that somehow a person needs to "gut it out and get on top of it." As a result of past or even present conditioning, we sometimes think and behave in self-defeating ways, especially if an injury is involved. Subconscious beliefs have far reaching consequences, both positive and negative, in every aspect of life. They affect moods, relationships, job performance, self-esteem, and even physical health.
It is imperative to know how to change limitations into beliefs that support our goals and aspirations.

Negative thoughts not only impair athletes striving to perform at their best, but it also reduces serotonin levels in the brain. A high level of serotonin is directly linked to superior job performance and leadership ability. Low serotonin levels affect the athlete's emotions and thoughts, leading to a less hopeful attitude and a reduced threshold for the guarding response, not only during the competition, but during training (and in all walks of life, for that matter).

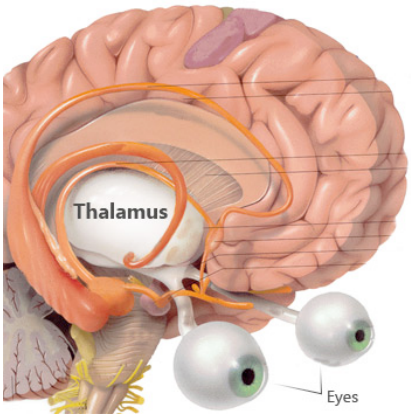
High arousal from negative thoughts, fantasies of fame and fortune, and excessive stimulation can also prematurely debilitate an athlete. Golfers, tennis players and baseball players can fatigue their fast-twitch muscles (critical for fast movements like swinging a bat, racquet or golf club) before they even begin their game. There have been only too many occasions where the stress surrounding a competition or Olympic event has brought a top-notch athlete to his or her defeat! Managing arousal increases the chances of being in the optimal psychological and physiological position for peak performance. This concept is not limited to sports performance, but also applies to all areas of life including the performing arts, public speaking and academics.



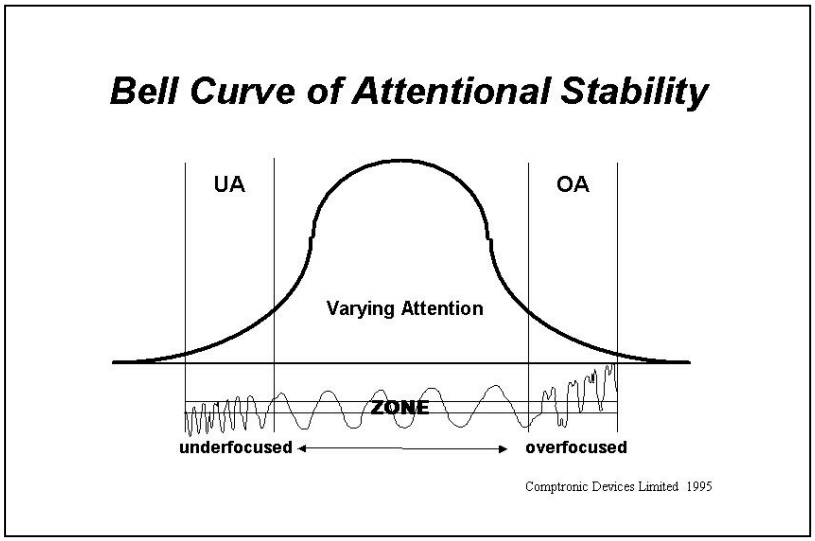

Our cutting edge research throughout 2010 allowed us to document over 125 cases of changing subconscious belief patterns to create what we identify as the *whole brain state*. This is amazing to say the least. The whole brain state is a balanced use of brainwave patterning seen in optimal performance both on and off the athletic field. The process used to change the belief patterns has been available and used very successfully for over 20 years. Now we have the ability to measure it and see the real effects on the brain. The depiction at the left is the result of what is known as an independent t-test. That is when you compare one condition to another condition to see if there is any scientific relevance to the two brain states being compared. Our technology is amazingly sophisticated, allowing us to compare several million data points in the brain to show how the brain is responding after the subconscious belief patterns have been affected.

The RED in the depiction above indicates the dominant brain pattern PRIOR to the facilitation of the change in subconscious belief patterns. The BLUE indicates the dominant brainwave pattern AFTER the change in subconscious patterning. The RED and the BLUE have come together to create the *whole brain state* as part of the optimal performance condition. The depiction for each person will be different, depending on what their brain needs to create for the integration of both hemispheres of the brain.

Another part to creating the optimal performance condition deals with influencing the thalamus of the brain. The thalamus is an almond shaped part of the brain that is partially responsible for creating and regulating the different frequencies in the brain. We also use Audio Visual Entrainment (AVE) to aid in the desired performance equation. Audio Visual Entrainment will tell the thalamus of the brain, "…see these flashing lights, do this!" The brain will then produce the frequencies it is being asked to mimic. The chemistry of the brain is altered and the brainwave pattern presented is affecting thought and physical ability.




Research conducted by the Shealy Institute indicated that just 30 minutes of Audio Visual Entrainment (AVE), sometimes identified as *light and sound therapy*, the stimulation with white lights increases serotonin levels by approximately 23%, which increases hopefulness, self-esteem and the drive to win.




The ability to concentrate and stay focused strongly influences an athlete's performance. The figure to the left shows how arousal influences an athlete's ability to perform in the peak-performance state. There are many stories of normal people who suddenly become "super humans" performing acts of heroism in a crisis, being pushed from the hypo-aroused state into the peak-performance state. But most athletes train in a fairly optimal peak-performance state as it is. However, on game day, nearby distractions (such as camera crews, celebrities, crowds, noise and the "big money" excitement of winning), interfere with the athlete's ability to focus. This pushes the athlete's arousal and attention from the peak-performance state into a hyper-aroused state as shown on the right-hand side of the figure above. This occurs when the athlete is mentally too "wired" to function in the peak-performance state. This highly anxious state influences the athlete's attention, impulsiveness and hyperactivity. The rhythm of the brain has lost its ability to remain stable; the neurons are firing too quickly and too often. The result is over-focus and mental mistakes.

In 1988, the Dallas Cowboys' sports psychologist, Bob Ward, used *light and sound* (AVE training) to help the football players visualize passing, kicking and other skills. He also used AVE units equipped with view holes in the eyeset and put the AVE unit into the players' fanny packs so they could receive AVE while running at practice. Bob noted that the players ran further in less time when running with an AVE system. He believed that, on their own, the player's performance was hampered by a mental protective mechanism. He also believed that the real inhibiting factor came from their conscious mind and that at some point during their run, when they believed that they had run far and long enough and that they shouldn't push so hard, they slowed down! This supports the belief *that what we believe is possible actually affects our physical ability*. For example, it was once thought to be impossible for humans to run a mile in less than four minutes until Roger Bannister proved it was possible in 1954. Prior to this historical race, Bannister received not only intense physical training, but psychological training as well! Since Bannister broke the four-minute mile, many others have followed. Now an Olympic level athlete must run a mile under four minutes in order to qualify!


Another example of how AVE has been used to enhance sports performance involved an amateur tennis player. He was experiencing pre-game anxiety which was costing him games because of mental mistakes and muscle fatigue. Not something many athletes would confess to someone. After using AVE for only one season, he was pleased to report that he had improved his overall standing from 150th place to 47th place.

Olympic speed skater Christine Boudrais used AVE training to help with her emotional healing following a serious accident during competition when another skater collided with her. Fear of the accident haunted her and interfered with her training and competitive edge. She believes that using the light and sound helped her

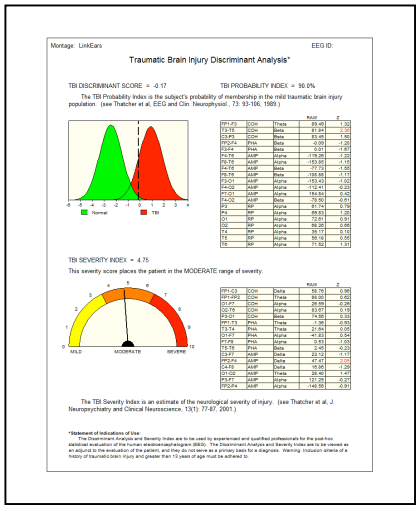
get back onto the ice with the mental power to compete and win again. She went on to Lillehammer in 1992 to win a silver medal!

Rocky Thompson worked relentlessly on the mechanics of his golf game but it wasn't until he settled down some anxieties about his performance that he showed remarkable improvement. Two weeks after Rocky's introduction to light and sound, he attributed his win at the Seniors Digital Classics in September, 1991. AVE increased his relaxation, with his body more relaxed he made better decisions, allowing him to deliver the shots he needed to win. Throughout his career, his anxiety cost him many games. But by learning to relax, he could play the game at the level his body and mind were capable of!

Over the years, many golfers have successfully used AVE to improve their game. Golf, like chess, is a tough mental game and golfers show tension all too well. Many golfers play an excellent game at practice, but do poorer under the stress of competition. When a golfer experiences anxiety, it will often be reflected as increased back tension and poor decision making. Sometimes, just hearing a tape recording of golf balls being driven will produce anxiety responses in a "struggling" golfer. The same is true in all sports; triggers can be developed in many ways that will cause the subconscious to act on the belief patterns that are residing there.

Another area of concern in sports neuroscience is this issue of head injury. Nearly everyone would agree that the problem of head injury sometimes has lingering and long-term effects. The National Football League is replete with examples of head injuries that have sidelined players, ended careers early and even crippled players for life. The effects of some injuries are not manifest until the player has left the game. This is an issue that the NFL Players Association continues to wrestle with to find a solution.

One of the biggest issues in dealing with a sports head injury is the ability to accurately identify whether it exists. Advances in technology allow us to not only determine the presence of a head injury but to take corrective action with astonishing success to get the player back in the game quickly.


Montage: LinkEars EEG ID:

Traumatic Brain Injury Discriminant Analysis*

TBI DISCRIMINANT SCORE = -0.17 TBI PROBABILITY INDEX = 90.0%

The TBI Probability Index is the subject's probability of membership in the mild traumatic brain injury population. (see Thatcher et al, EEG and Clin. Neurophysiol., 73: 93-106, 1989.)

Normal TBI

TBI SEVERITY INDEX = 4.75

This severity score places the patient in the MODERATE range of severity.

MILD MODERATE SEVERE

The TBI Severity Index is an estimate of the neurological severity of injury. (see Thatcher et al, J. Neuropsychiatry and Clinical Neuroscience, 13(1): 77-87, 2001.)

*Statement of Indications of Use:
The Discriminant Analysis and Severity Index are to be used by experienced and qualified professionals for the post-hoc statistical evaluation of the human electroencephalogram (EEG). The Discriminant Analysis and Severity Index are to be viewed as an adjunct to the evaluation of the patient, and they do not serve as a primary basis for a diagnosis. Warning: Inclusion criteria of a history of traumatic brain injury and greater than 13 years of age must be adhered to.

Recently, I was able to execute a number of QEEG brainmaps on individuals preparing for the NFL Combine. The depiction at the right is part of the advanced technology used at the Center for Cognitive Enhancement to identify and take corrective action with regard to head injury. In neuroscience, this would be identified as a *Traumatic Brain Injury Discriminant*. This discriminant identifies this athlete with a 90% probability that he had experienced a moderate head injury. Analysis of the data will reveal where and to what degree the head injury has impacted the player so the corrective neurofeedback treatment could be applied.

As today's technology is being used more and more in sports, the day is fast approaching when players and prospective players will be routinely screened for head injuries. It does not take much imagination to realize that signing a player or trading for a player will soon require a certificate that they have been cleared of any traumatic brain injury. Competing at a high level means taking risks, head injuries frequently occur even in non-contact sports.

Consider the example of major league baseball player Sean Casey. He was drafted in 1995 in the 2nd round by the Cleveland Indians and was traded to the Cincinnati Reds before the 1998 season. Casey had his best year in 1999 hitting .332 with 25 HRs and 99 RBIs and 103 runs scored in 151 games. In 1999, he won the Hutch Award.

Sean Casey was signed to the Reds through the 2006 season. However, he was traded December 6, 2005 to his hometown Pittsburgh Pirates for left-handed pitcher Dave Williams. During an injury plagued 2006 season, Casey's hitting and performance was up and down and never able to get above .296 with three home runs and 29 RBI in 59 games for the Pirates. On July 31, 2006, Casey was traded to the Detroit Tigers for minor league pitcher Brian Rogers. As a prized player, with a tremendous start to his career, he was experiencing the downward slide of his career that seemed unstoppable. That is, until Shawn discovered the *real reason* for his faltering career. What many do not know about his story are the issues behind the scenes that only recently have come to light by Casey's own admission. One of the multiple injuries that he received was being hit in the head by a fast ball. It would be easy to understand that a 90-mile-an-hour fast ball delivered to the head might have some impact on his brain's ability to perform in an optimal range. That is when Sean Casey came in contact with neurofeedback brain training. He began to use this process to improve his performance. It did just that!

On February 5, 2008, the Boston Red Sox officially announced they had signed Casey to a one-year deal. On April 9, 2008, Red Sox third baseman Mike Lowell injured his thumb and was then placed on the DL, first baseman Kevin Youkilis was moved to third, and Casey stepped in as the starting first baseman and exploded by making some good defensive plays and hitting .318 with five RBIs in his first seven games. Shawn Casey finished the regular season with a .773 OPS on 199 at-bats in 69 games.


Casey announced his retirement on January 25, 2009 at the age of 34, having played 12 seasons of Major League Baseball. He currently serves as a baseball analyst for MLB Network. On July 3, 2009 he sat in for Red Sox color commentator Jerry Remy, calling the first game for his old team.

A career turnaround of astonishing proportion…yes. Was it mind over matter? To some degree it was, but not in the sense of shaking it off and gutting it out. Sean will tell you that it was the ability to train his brain and eliminate the devastating effects of a fast ball that altered the performance of his brain. Neuroscience, brain training and head injury diagnostics have evolved to a level of sophistication that teams and players are aware that they can do something about training for optimal performance. Even if they are recovering from an injury, they can quickly to get back to the level their sport demands. Whether you are a player or a team, you don't have to sit on the sidelines when it comes to training your brain, t*he best way to predict your future is to design it!* -JLF-