Proving a Neurodynamical Theory

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Abstract

In this article, we examine the basic problems of proving a neurodynamical theory and present an example of how the KIII Theory was implemented and examined in a sports training program.

1 Introduction

The sum total of our knowledge of the human brain arises from (1) experiments on animals; (2) medical cases of humans with some form of brain trauma; (3) statistical correlations from studies of psychology and sociology. However, direct quantifiable examination and study of normal humans engaged in normal activities is what would best confirm a theory. Specifically, direct quantifiable cause and effect data, rather than statistical correlations, are what is needed for sufficient proof of a neurodynamical theory.

To ”prove” a neurodynamical theory it would be sufficient, in addition to accounting for laboratory experimental results, to answer the three key questions in Table 1 below:

1	How is intentionality communicated to the relevant action regions of the brain?
2	How do humans learn?
3	How does the human rapidly adapt to change?

Table 1 Key Questions for Proving a Neurodynamical Theory

Any program to prove a neurodynamical theory must be able to use normal human subjects performing normal human activities. To establish such a program three conditions must be met: (1) Find a simplified venue within which the key issues that bar our ability to answer these questions can be examined; (2) apply our knowledge of the dynamics of the human brain theory to this venue to construct a minimal system to test and prove hypotheses that will provide the foundation on which further developments can be based; (3) establish specifications for the design of systems which are broad enough to encompass a wide range of human enterprises.

In this paper I will select a venue for testing the KIII Theory and construct, using that venue, a minimal system that will address the three conditions cited above.

2 Experimental "Proof" of any Neurodynamical Theory Poses Serious Challenges

Sufficient proof or "validation" of the KIII Theory, through reproducible human experiments poses virtually insurmountable challenges. The bureaucratic paperwork alone is a sufficient roadblock to human experimentation; but, equally serious is this: How can human experiments ever be conducted and rigorously measured, much less be made reproducible without direct access to the object where the dynamics originates?

Clearly, access to normal human brains is out of the question; but, using only animal brains does not provide conclusive evidence of proof; nor does such insights lead to furthering research on human system design. Also, while EEG's are our best guide to the real time dynamics occurring within the normal human brain, having humans perform complex tasks while recording EEG's is a problem of technology that is presently out of reach. A central question in this: Is it possible to develop a program that involves normal humans engaged in normal human activities that will be a legitimate data source to provide insight and indirect confirmation of a scientific theory of human brain dynamics?

To review: (1) It is impossible to sufficiently confirm a theory of neurodynamics without direct access to the human brain; however, direct access to the human brain necessarily corrupts the very object to be observed making all data invalid or conditional. (2) To observe normal humans doing normal activities requires an approach that compromises the "reproducibility principle" of scientific experimentation because of the possibility that any measurement will corrupt the desired data by modifying the normal activity to conform to the requirement of an objectively reproducible metric. (3) Any program that involves studying normal humans engaged in normal activities cannot be scientific in the formal sense.

The alternative to having a reproducible scientific program is to develop a program that is derived from the implications of a theory of brain dynamics in which normal humans engage, uninterrupted, in normal human activities; such activities have limited reproducibility and only supplements formal experimentation. Since a key to scientific proof is the ability to predict new or existing outcomes based on a theory, we are compelled to use the simplest possible human enterprise as a basis for the implementation of a program that is grounded in the predictions of a theory. Once the program is structured according to the predictions of a theory, it may be tested for correctness within a properly chosen context.

Of all available venues that are of short duration and which involve a simple human system, sports may provide the best choice for implementation of the KIII Theory. This would require developing a sports training program with which to test the KIII Theory. Four specifications must be met: (1) The program would be a training program in which humans acted as a model of a simple human system; (2) the training program would necessarily be constructed around mesoscopic dynamics; (3) the program would require training that presses the limits of human performance and endurance; (4) the program would have to provide the highest degree of complexity available in the sport. Specifications (3) and (4) are necessary to discriminate between the neuron theory and the KIII mesoscopic wave-pulse theory in speed of adaptation and learning.

Since our selection of the best platform on which to develop a training program is sports, the training protocol would have to:

1. "Instantiate" the KIII Theory in the training program
2. Train athletes according to the instantiated protocol
3. Test the athletes in the arena of competition
4. Correlate the theory to the success of the athletes

Competition would have to be against athletes who were trained in existing programs which do not have access to the KIII neurodynamical theory; and, the sport chosen would have to offer the opportunity to observe and train for the full range of human dynamics.

3 Instantiating a neurodynamical theory in a sports training protocol requires deriving relevant sports training activities from the theory

Instantiation of a neurodynamical theory in a sport requires deriving the mesoscopic components of the actions used in the sport from the principles of the KIII Theory. However, before we present the results of that analysis, we had to understand "why" the brain operates from mesoscopic components and wave-pulse dynamics rather than neuronal dynamics. To do this we had to turn to paleoanthropology and the evolution of the human brain in a primitive environment.

3.1 The Paleoanthropology of Brain Evolution Provides Insights into Training Protocol Design

Perhaps the most important matter that needs clearing up is the role of language in the formation of mesoscopic components of action. It is common to see teaching pros in tennis spending a great deal of their time talking. For example, a particularly obvious case I witnessed was of a pro spending 30 minutes instructing a student on the serve. During this time, he spoke for 25 minutes and she only hit serves for 5 minutes. Needless to say, very little was accomplished. The route to mesoscopic component formation, if forced to go through verbal language translation, will be inefficient and may even obscure implementation of the KIII Theory. This point is of such primary importance in implementing the KIII Theory that a very detailed discussion is in order. This takes us to an analysis of the origin of procedural/implicit learning versus declarative/explicit learning in the role of human athletic performance.

Fossil records found in the Awash region of Ethiopia show that hominինae have been making tools (a mechanical skill requiring mesoscopic component formation) as far back as 2.5 million years ago (mya) [1]. But what happened to set this stage for tool making? Certainly there were no examples to follow for the first tool makers so trial-and-error was their only means of discovery. However, there was another factor on their side: individual initiative driven by purpose. We know that this ability, which may also be called ”intentionality”, evolved at least 370 mya with the appearance of the limbic system in the brains of amphibians [2]. These facts imply that evolution selected trial-and-error combined with initiative as an early successful method of learning for the predecessors of humans. Neuroscience today supports the presence of a trial-and-error mechanism in the brain in the form of ”chaos”, the only formal dynamic that has the property that we refer to as ”random” [3]. Further, we know that animals had to develop learning by example, such as an off spring mimicking a parent’s feeding method, to survive. The stability of these forms of learning over millions of years as demonstrated by paleoanthropological and biological records, over many species and through dramatic environmental changes demonstrate their primacy in the process of natural selection. Their primacy is further reinforced by the principle that evolution builds on existing capabilities to advance skills and performance rather than spontaneously discarding existing skills wholesale in favor of new, better skills [4]. The implication is that procedural learning is so fundamental to the evolution of the human learning process that all other forms of learning must be in some way related to, and built on, this form of learning. Supporting this assertion is the fact that an examination of fossil and biological records shows that two of the components of the brain required for mimetic and trial-and-error learning were developed early. For example, the cerebellum needed for mechanical skills such as coordination of body movements developed in fish [5], Section II Chapter 3 at least 400 mya; and, the limbic system needed for other learning and movement skills emerged with amphibians as noted above. Other essential components for learning, such as emotion [6], [7] emerged in mammillae about 300 mya [8]. Learning traits that built on emotion continued development in likely human ancestors such as sahelanthropus over 7 mya [9], [10]. We can even conclude that procedural learning is essential for speaking and writing, both of which are mechanical skills used to provide declarative instruction.

Declarative instruction depends on language and writing. Clearly, writing is phylogenetically very recent [11]. Language development is not nearly as recent as writing, but is certainly much more recent than tool making, although approximate dating is still unsettled [12, 13, 14]. While it is argued by some that Homo habilis could speak [13, 15], the argument is not supported generally [1, 4, 16]. However, it is not likely that H. habilis could ”instruct” [16].

Instruction requires sufficient language to make fine distinctions between alternatives. But it also requires intent or the desire to direct. When a mother cheetah partially disables a prey item to be used to teach her offspring, she does not ”instruct”. Nor do chimpanzees instruct other members of their clan in how to make a straw tool. The ability to provide verbal instruction or even nonverbal direction is a change in the world view of humans from previous learning styles which were procedural, and perhaps hands-off. Even with the development of sophisticate grammar, the act of instruction does not necessarily emerge. Instruction or ”direction” versus demonstration is an entirely new skill or trait. So our analysis centers on when the trait of instruction emerges, not just language.

Activities requiring many individual small steps, that need precision and whose individual relevance is not obvious, characterize the situations requiring both instruction and precise language. Cultural activities and customs do not necessarily require a precise series of steps. But making tools that are ”sophisticated” does require precision, language and memory. So three evolutionary steps are needed for the emergence of instructional tool making: Precise language, long term memory and the trait of instruction. All of these traits were late in formation and therefore were acquired long after mesoscopic dynamics emerged in the human brain.

The verbal instructional skills of Homo ergaster and certainly Homo erectus are more complex issues. One must imagine that the urge to instruct may have arisen from the urge to control. And once some form of verbal communication came into being, it could provide a mechanism for control just as it does in all animals with the ability to vocalize. However, instruction requires a degree of ”refined” communication well beyond the use of sound to control and communicate displeasure. H. habilis’ tools seem to indicate that no such refined communication existed. H. ergaster and H. erectus were tool maker having a measure of standardization, but little complexity, in their tools [16]. The fact that there was little evolution of their tool making skills over many years suggests that there was also little evolution in their instructional skills. So their abilities might best be attributed to mimetic learning [4]. It would seem more reasonable if H. ergaster could instruct, their ability to instruct would have expanded, as is common with modern humans. Further, one would expect that instructing would have resulted in skill advancement, as is commonly seen today. H. erectus is claimed to have a well developed Broca’s area [16], an area essential for speaking [6, 7]. While there is some argument possible to support some language development for social skills, the language for instruction requires far more precision. So, in addition to Broca’s area, H. erectus would also have to have the physical vocal structure to produce a sufficiently wide range of sounds for instruction [1, 4]. And further, the usefulness of words for instruction would have needed the development of Wernicke’s area for language comprehension [18].

It is instructive to relate the ability of prehistoric humans abilities to speak to the types of aphasias that can occur when speech areas are not completely intact [7], Table 59-2. Since it is not reasonable to expect that all of these language areas would develop in full form spontaneously, there would have been periods in which the language ability of H. erectus would have resembled aphasias making it difficult to perform precise instruction. In addition to the development of the preceding areas, lateralization would also likely have had to occur [4]. But this is not enough. It is likely that an expansion of Wernicke’s area beyond what is seen in chimps and rhesus monkeys would be necessary [19]. We can only guess at what era all of this first formed (however, Kyriacou and Bruner [20] provide an excellent and intriguing analysis of many of these issues) and our most unequivocal clues are tool making skills, tool standardization, culture and brain size [4, 21]. Brain size is a bit ambiguous as demonstrated by the large brain of H. neanderthal [1, 16] and by brain sizes of modern humans [22]. An intriguing, but, from the fossil records, unverifiable possibility to explain the ambiguity of brain size can be found in recent research into the glial mass of the brain [23, 24].

Tool making, and especially tool standardization, are useful metrics for the evolution of instruction, but culture is also a candidate for the development of instruction. The fact that Neanderthal’s culture was nowhere nearly as advanced as H. sapiens [19] even though H. neanderthal had a larger brain suggests that H. neanderthal had less instructional skill than H. sapiens. Hence a good metric is culture but the best metric is tool sophistication and this is where we have some better reference points. In particular, even a culture in which language existed to express subtle ideas such as religion, or a culture that needed language to settle disputes would be more likely to support tool making instruction than less advanced cultures. To be efficient instruction and to be replicable over long time spans before writing evolved, language would need to be very precise allowing for descriptions of many ”abstract” steps. To have a true explicit learning, it would be necessary in a large group to teach members of the group how to instruct others. Our best guess for this level of language versus speech acquisition is likely not better than 200 kya but more like 100 kya [17] but even 500 kya would represent a very short development time span for explicit instruction versus implicit instruction, showing that the implicit instruction had a developmental head start of over explicit instruction of over a hundred million years.

One could argue, using the principle of evolution alluded to previously, that the explicit instruction is built on implicit instruction and is hence even more advanced than implicit instruction and more appropriate to teaching mechanical and athletic skills. There are connections in the brain between these two forms of learning, so this sounds like it could be a good argument to counter the claim of the statement ”It is unreasonable to argue that the evolution of the human brain would have made a sudden change and jumped from learning tasks by trial-and-error and observation to learning tasks by following directions” since no jump was necessary by this hypothesis. If we fast forward to modern Homo sapiens sapiens appearing around 200 kya [25] who could speak and communicate methods and ideas, we can clear up this argument quite nicely. It is now known from modern neuroscience that implicit instruction and explicit instruction are quite separate and that explicit instruction was not an extension of implicit instruction, but an entirely new ability. One of the most persuasive sets of examples of the separation of procedural and declarative learning and therefore instruction are the cases of epilepsy patients who have had bilateral removal of the hippocampus and adjacent parts of the brain in an effort to control seizures [7]. What has been discovered by such surgeries is that the patient can continue to learn and improve the execution of complex mechanical tasks without having any memory of ever having practiced the task. Thus we see that procedural learning, or learning a task, proceeds without any need to remember that learning ever took place. This is not true of explicit instruction. As a normal example, the inability to remember learning or executing a mechanical task is evidenced by how common it is to hear a professional player say that they have no idea of how they hit the ball. The epileptic data can be supported with simple tests of normal human beings. Conducing a test that anyone can perform, the subject player is asked to show in slow motion how they hit a ball. Then they are videoed hitting the ball. What will be seen is that their idea of their movement is unrelated to their actual movement. This test is one that most teaching pros could conduct but consistently overlook.

From the small segment of data available from the study of paleoanthropology we have presented here, we can conclude that implicit learning has been the dominant form of learning for millions of years, with the first components of implicit learning emerging at least 400 mya. Thus implicit learning drove the formation of the mesoscopic components of physical action. Explicit learning appears much later and is not a simple evolutionary extension of implicit learning. Implicit learning is designed to utilize experimentation and exploration, imagination, motivation, and mimetic learning. Explicit learning relies on language and in particular, very precise language and has only been in development for less than 500,000 years at best. This is also supported by brain phylogeny described by James Olds in animals [5] Section II Chapter 3: 253-271. These facts speak to how fundamental procedural learning is to the human learning process in the development of mechanical skills. This is even reflected in childhood development. For example, one would not think of trying to teach a child to walk by using verbal instructions. Further, results from neuroscience cited above support this evolutionary view. The evolutionary view presented, and the role of experimentation, exploration and intentionality all argue for the KIII mesoscopic wave-pulse theory of neurodynamics on which our training protocols were developed.

3.2 The Final Selection of Mesoscopic Components were derived from the KIII Theory and Its Implications

We begin by tabulating the minimal factors that must be instantiated in the sports training program based on an understanding of the KIII Theory and its implications:

Factor	**Relevance**
Sports Specific Mesoscopic Components	Key to the KIII Theory
Component Purpose	Intentionality Driven
Experimentation	KIII Implies Individual Initiative
Numerous Samples	KIII Implies Successive Approximations
ARTT	KIII implies rapid responsiveness to Extremes
Stress/Fear	KIII implies Rapid Adaptation to change
Complex Environment	KIII is Chaos Driven
Hands Off Approach	KIII implies Self Organization

Table (3.2) The minimum number of factors that must appear in a training program to instantiate the KIII Theory (ARTT)[1]

While most of the factors in Table (3.2) are self explanatory, the factors of Fear/stress and ARTT require some explanation. A wave-pulse mesoscopic theory allows for rapid response to surprise, fear, stress and circumstances that challenge the limits of human performance. To test the KIII Theory it was essential to challenge the limits of human performance and endurance, particularly in responding to fast-paced events. To do this we introduced many stress related activities that contributed directly to student development.

To develop an instantiated training protocol, four problems must be solved: (1) Selecting the sport which requires a broad spectrum of complex human thought and action and which can be used to acquire real time, accurate information about the neurodynamics of the normal human brain engaged in normal activities; (2) determining how that activity can be objectively and numerically measured; (3) determining to what extent the sport can provide data that is accurately reproducible by independent researchers; (4) determining how can we assure that the measurement process does not disturb the object being measured and thus bias the results?

The answer to (1) is a sport requiring a full range of physical, emotional and mental activities. Of the various possibilities available, tennis was selected as the venue. The selection of tennis was motivated by several factors. Chief among these factors were (1) its complexity; (2) it is a combative sport (3) it is a one-on-one sport. Complexity was determined by the extent of the involvement of every part of the mind and body in the execution of an action.

Tennis being an eye-to-eye, one-on-one combative sport assured that tennis presented the potential of the combatants to experience very personal fear.[2] It is an important for testing the KIII Theory to know the level of personal fear that a sport provokes. [3] The importance of the fear level is several-fold: Fear engages the fight-or-flight response; it stimulates the use of reflexes over voluntary actions; it challenges

[1] Above Real Time Training (ARTT) is a protocol which calls for all training to proceed at a far faster pace than would be experienced in real time

[2] It should be mentioned that Mixed Martial Arts (MMA) is likely equally complex as tennis and shares many of the same traits as tennis, most importantly it is an eye-to-eye combative sport that must stimulate the limbic responses equal to those of tennis and war. However, MMA involves subjects being hit in the head and that is an event that was determined to possibly compromise the subjects skill development. Also, MMA was ruled out due to its inherent risk of injury.

[3] We have worked directly with a MMA cage fighter and a middle linebacker for a professional football team; both have confirmed that the fear level in tennis exceeds both MMA and football. Both athletes believed that this difference was due to the fact that in tennis, the players have time to think, especially when serving or between points.

the seat of intentionality and as such initiates the wave that must reconfigure local mesoscopic assemblies in response to input from the environment over a relative short time span.

Tennis also has an additional component supplied by parental and peer pressure in real time. These additional distractions are consistent with a primitive environment in which the subject would have to be aware of many factors around them or lurking in their environment while maintaining concentration on an activity such as hunting. Also, these threats subject the players to external psychological stress that can be amplified by their internal world view.

A third factor is that tennis is played out on a venue sufficiently small to be observed and recorded from any angle. Another factor is that tennis has no time limit. The combatants cannot be ”saved by the clock” exactly as in a primitive environment. This factor places great demands on physical conditioning and guts. Also, the rules of tennis allow for one combatant to hit another with the ball to win a point. Due to the speed of the ball (as much as 100 mph) and its hardness, such hits can be very painful and thus provide the possibility of real physical harm in the minds of the combatants. It was in such a primitive ”Darwinian” environment that evolution would have selected brains which could communicate from the seat of intentionally to various parts of the brain responsible for responding to threats quickly and which would be composed of mesoscopic components that could be used in diverse ways. As a result of these considerations, tennis was deemed to be the only sport that provides the opportunity to observe normal humans performing safely under virtually primitive conditions within a controlled environment.

Today, the USTA has designated a variety of formats for tennis instruction and competition. The most recent is the introduction of balls having varying levels of compression (called low compression balls), smaller racquets and smaller court sizes. These additions were introduced in the interest of reducing the complexity of tennis and the challenges of the faster standard ball and larger courts for students of ages 10 and under, presumably, to make it easier for average kids to enter the game of tennis. However, to insure that the KIII Theory could be tested in the broadest context, we chose only the standard yellow ball (the key specification: rebound 55 inches when dropped from 100 inches) and standard 78 foot courts and adult racquets. This choice assured that all students would be exposed to the maximum level of complexity that tennis could offer, and thus would provide an environment as close to a primitive environment as possible. [4]

[4] It is well known that complex environments provide greater stimulation of the brain than environments that have been modified to facilitate ease of decision making and skill application. To test the

4 Acquiring Useful Data from a Training Venue Requires a Hands-off Approach to Observation

Having chosen a sports venue, the next problem is to acquire data without the limitations or benefits of the laboratory. Several factors of protocol had to be observed:(1) There could be no announcement of clinical trials because such an announcement immediately invalidates the data we are seeking just as would processing the study through a bureaucracy corrupt the data; (2) there could be no advertising or proselytizing, student had to appear ”by chance” encounter; (3) the program must be just another tennis academy; (4) the method of instruction must not invalidate the data; (5) there could be no persuasion tactics that could influence the decisions of persons seeking tennis training; (6) however, it would be permissible to post that the program was scientifically based on current research and was not a conventional program.

To achieve the objectives listed above, it is necessary to implement the KIII Theory in a sports training program that is just a ”commercial” tennis academy since making the program a 501(c) necessarily biases the potential ”clients”. With the commercial approach, the KIII Theory was, in effect, tested by the market in addition to the factor of competition. To maximize credibility the following questions had to be answered: (1) What is the ”right” training protocol? (2) How is data to be collected without introducing the dynamics of the instructor into the data? (3) How are results to be measured? (4) How can reproducibility of the results be assured by an independent scientific team?

Those questions received the following answers: (1) The protocol must be designed by deriving implications of the KIII Theory that could be translated into measurable units of instruction on the court; (2) A protocol had to be developed, referred to as the Passive Observer Protocol, that eliminated to the maximum extent possible instructor corruption of the data; (3) The ”metrics” to be used to measure progress were reduced to three: (a) the time training started; (b) the success of the student in formal competition; (c) the medical prognosis of the student upon initiation of training, if any. To this end, we only consider students who have participated in the program two years or less and are in the program at the time of this publication.

Since there could be no claim of scientific formality, it was neces-

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KIII Theory throughly, it was essential that we put students to the most extreme challenges that could be provided by the sport of tennis. If the KIII Theory is valid for normal humans, then the increased challenges would evoke greater responses and adaptations by all students, especially students having some form of limitation. The responses should appear in the form of more rapid development due to complex stimulation. All of our data confirm a rapid response correlated to greater complexity.

sary to design a program that would be commercially viable and available and for which success was determined by the marketplace alone rather than laboratory standards for testing humans. In short, the program was just another tennis program that one could take or leave at their discretion. In every possible way, the program could not have any of the trappings of a laboratory experiment; and so, no commercial advertising could be conducted. It was required to be just another market alternative tennis "academy" that would succeed or fail on its value to the customer. This approach posed very serious risks, the most serious of which was "What if the program turned out not to be commercially viable?". In this case everything would be lost because we would have learned nothing that could lead to a course correction and a second try. That was a risk we had to live with. Another risk was the possibility that no "subjects of interest" would ever enter the program. This real possibility resulted in only sporadic players entering the program who had normal human limitations.

Students of interest fell into two categories: (1) students who were poorly coordinated relative to the demands of tennis; (2) students who had limitations due to past injury or condition but were not restricted by that condition to the extent that they could not learn to play tennis. Additionally, the program had to accept just plain normal students who were seeking tennis instruction for various "every day" reasons such as wanting to improve their game or obtain a college scholarship.

To address *What is the "right" training protocol*, a detailed analysis of tennis technique had to be carried out. Specifically, all elements of technique had to be reduced to mesoscopic components. This required the analysis to closely follow the results of [3].

After some analysis it was decided that the athletic analog of a mesoscopic component from [3] must be the simplest possible motor action component that would have a purpose. Purpose was included to assure intentionality was present. This was necessary for validation of the theory as well as the fact that this was well supported by the research of Langer [26] at Harvard. We know from the research of Langer that motivation or intentionality would be an essential component for learning as well as for neurodynamics. This was consistent with the KIV theory, and extension of the KIII Theory to include intentionality. The nature of tennis itself provided the answers we needed, see Fig.(1).

FIGURE (1)

Mesoscopic Component	**Component Action**
Primary Component	Contact between the racquet and the ball
Secondary Component 1	Extension through ball path
Secondary Component 2	Rotation of Racquet Head into ball path alignment
Secondary Component 3	Acceleration of Racquet into ball path
Secondary Component 4	Initiate racquet forward advance
Secondary Component 5	Retract racquet into starting position

Each simple component was selected to be versatile, i.e., useful in serving more than one purpose.

5 Intimidation, Pain and Fear are Fundamental to Combative Sports

In addition to the technical factors of the sport that required the derivation of mesoscopic components, we also had to consider two other factors: Physical conditioning and mental toughness. Without these additional components, no valid test of learning could be formulated since both conditioning and mental toughness both can ”trump” technical skill. This meant that no matter how well mesoscopic components were acquired by the student, their ability to use these skills in the sport depended on their conditioning and mental toughness. In fact, skill could be completely lost due to the extreme stress of formal match competition [27]. As a result of these known facts, we had to develop a program that supported skill development with physical conditioning and mental toughness training. This consideration required that we derive our program from the principles of eye-to-eye combat. There are three that apply to all combat from MMA to Tennis to war and they are derived from the single most important principle of combat: to break the enemies/opponent’s will to continue, Table 5

1	Intimidate the opponent
2	Make the opponent feel physical pain
3	Inspire fear in the opponent with your assault

Table 5 Principles in breaking the opponent’s will

To develop mental toughness we introduced the MMA training protocols of current bantam weight champion Ronda Rousey to further amplify the primitive demand on the mind and body. This included using MMA equipment such as body protectors to be able to include striking in the protocols. However, no head striking was allowed due to its risk of injury, see Fig. (2)

FIGURE (2)

To assure that physical fitness was never a factor in skill performance, we developed an extensive physical fitness program, Fig (3).

Each component of the physical fitness program had to be tied to mesoscopic component development. This assured that the exercise was relevant and driven by intentionality.

FIGURE (3)

6 Brief Summary of Derived Protocols

The mesoscopic wave-pulse theory, serendipitously, supported important research in the theory of learning by Professor Ellen Langer at Harvard [26]. Using her language to explain the teaching protocols provided a means of translating protocols from the difficult language of neuroscience into easy to understand language needed to train instructors.

Teaching by rote repetition, or teaching based on activities rather than results, stifles the imagination, creativity and individual initiative of the student, producing a student that cannot easily adapt to new and novel circumstances. This is a result of the lack of intentionality in the learning process. Match play requires the student to constantly adapt to the changing circumstances of the flight of the ball and the course of the match. Hence a player, or any student of any subject, taught by rote repetition will in general perform below the level of their capability and will not compete well against a highly adaptable student with lesser skills according to the KIII Theory and the work of Langer. To this end, the KIII protocol must encourage creativity, experimentation and exploration of all ideas; adaptability, autonomy, self determination. self advocacy, imagination, and individual Initiative. All of these traits would have been honed by natural selection and thus must be part of the KIII dynamic. In order to carry out this program of instruction:

- Each drill is presented as a series of experiments
- There is no wrong or right result for a drill
- The student is encouraged to avoid value judgments
- The students are to avoid having a preconceived ideas about their abilities
- All drills maximize the student's opportunity to experiment
- All drills encourage individual initiative and creativity
- There is no form of conventional template based training
- All drills are designed around conceptually clear purposes
- Each drill has an answer to the question ”Why?”
- Drills are based on the objectives of tournament play
- Learning is primarily implicit
- There is minimal elaboration or direction from the instructor
- Micro management of the student is eliminated
- Answers are is neither right nor wrong, but rather start of a dialog

The first phase of instruction with a new student is the discovery phase. During this stage the instructor just feeds balls to discover a student's central tendencies and reflexes and to see what they can do based on their own experience or genetic predisposition. This may take as much as a half an hour due to factors of nervousness and the student's preconceptions about what is expected of them. Preconceptions and reflexes may obscure a student's real abilities so they must be addressed early.

After the initial discovery phase is complete (discovery will go on throughout the student's learning process) the development phase begins. Once we have an initial idea of what the student can and cannot do, we can begin to introduce the key ideas of the various grips and what they can do and move on to contact, extension, elbow position, and movement.

7 Example Results

Our research and analysis concluded that the instruction protocol would have to diverge drastically from legacy tennis training approaches. Most importantly, as our analysis from paleoanthropology shows, the role of language or explicit instruction would require significant attenuation. As a consequence, micromanagement of the student would have to be eliminated and replaced with a minimalist approach whereby the instructor was "nearly" a bystander. This element of the protocol also supported the non interference requirement necessary to assure minimal corruption of the data but also was consistent with the KIII Theory. Consistent with the mesoscopic wave-pulse approach would be the inference that once a component was developed, it would be used in a variety of contexts without the need for explicit direction [8]. This drove the protocol to depend on the individual's initiative and creativity to "fill-in-the-blanks" with minimal assistance from the instructor. Therefore experimentation and exploration by the student was a necessary ingredient of the protocol. Further, the derived training protocol must make maximum use of mimetic learning which can proceed at a remarkable pace [6]; sometimes just a few minutes is all that is required. This is fully consistent with the mesoscopic wave-pulse theory and is also well-supported by the theory. Chaotic dynamics would be necessary as well. Chaos was included in several forms: constantly changing schedules; a random order of exercises and drills; surprise changes from projected schedules etc. The demand to adapt quickly is a consistent and necessary theme that must run through all training exercises and drills. The drills and exercises had to challenge the brain to develop and adapt due to the inherent difficulty of the program.

Within this complex environment, students from all walks of life were trained to play tennis and to execute even the most difficult and complex actions of the sport. Clearly, the demand to rapidly adapt to change in the face of fear and complexity is best explained by the mesoscopic wave-pulse theory. Another implication of this theory is that a part of the brain that originally starts out having a specific function could be reconfigured in a short time span to perform a different function based on the level of desire of the subject. A common example is that of the individual who, after losing the use of their arms, learn to use their feet for the original purpose for which the hands were used. An additional implication is that learning a sport must proceed from intense, nonverbal environmental activity [12]; further, the process of trial-and-error must be permitted [8]. One significance of including trial-and-error is that it allows for the brain to ”self organize” over very short time spans. Short-term self organization is consistent with the KIII wave theory but not with the static neuronal theory.

While our approach is to train normal subjects using the KIII protocol, having functionally normal subjects with some accidental or embedded abnormality would be most useful. Using this approach, a simple test of the KIII hypothesis could be conducted if a subject entered our program with a known physical limitation. This had to occur by chance since proselytizing and advertising were prohibited. As chance would have it over a 16 year period, players did arrive on our door step who had lost some range of motor action. We will only mentioned three here.

Case 1 A second example is of a subject who entered our program with an inoperable tumor on his brain stem. See Fig.(4) which includes the MRI of Dan T. dated 2011; and, the figure also shows Dan T is performing effectively in competition. His prognosis was not fatal, but that his ability to engage in complex athletics would likely never be possible. At one point, the mother of Dan T. was told not to remove Dan from hospital care because he would die. She ignored the doctor’s advice. By chance Dan T’s family was a member of the Plaza Oaks Club in Houston, TX out of which this tennis academy operated. She brought him, and his younger brother to Jana van der Walt, our head pro to begin lessons. Within two years Dan T was defying all the odds and learning to play tennis well enough to compete in formal sanctioned tournaments. In his second match, played in December of 2014, Dan T took his match to a third set tie-breaker against a far superior normal student.

Dan T’s starting point in our program requires mentioning. When Jana began feeding Dan balls that were high, he would duck; on some occasions the ball would hit Dan as he was unable to make decisions about how to adjust to the ball path. The significance of this is that in Fig. (4), Dan is hitting a ball out of the air in a formally sanctioned USTA tournament. This photo demonstrated that not only had

Dan formed the mesoscopic components of movement to adjust to, and track the ball in an extraordinarily short time span, he did it under the pressure of competition.

FIGURE (4)

Serendipitously, two important points emerged from the fact that Dan T was trained independently by Ms. Walt without any advice beyond following the KIII training protocol: (1) the method itself was demonstrated to be transferable; and, (2) that implementing the KIII Theory in a sports venue may be independently verifiable.

Case 2 A third example is that of Jean V. See Fig. (5). Jean V destroyed his knee in motor cross training. The exact diagnosis from the MRI of the left knee joint was: *Acute full thickness versus near complete mid substance tear of the posterior cruciate ligament. Anterior cruciate ligament is intact. High grade sprain of the of the proximal superficial medial collateral ligament. Moderate tear of the medial collateral ligament. There may be a complete tear at the femoral origin. Oblique tear within the middle and peripheral thirds of the posterior horn of the medial meniscus.* The rest of the knee was found intact.

Jean V's injury was a result of a fall while involved in motor cross training. Surgery was recommended, however, Jean V elected to use our program as a rehabilitation venue on the premise that his brain would, with extreme intentionality and determination, shortly reroute his muscle groups to allow him to return to playing competitive tennis. Full dynamic recovery occurred within less than three months. In addition to Fig.(5), Jean can be seen grappling in the MMA figure, Fig. (**??**), bottom right plate.

FIGURE (5)

The foregoing examples are of students who had some limitation that was readily overcome by the KIII teaching methodology. The following examples are two students who have no limitations and were candidates for professional tennis. However, the student's parents thought that they could do even better and moved the student to another program. This provided us with an excellent opportunity to make a direct comparison of KIII theory development with conventional methods. A key to understanding the figures is the RPI, or Relative Performance Index. This is a number that is calculated each week by IMG for all amateur sports. It measures the candidates performance relative to their competitors. This is the only relevant decision making factor that is a pure number that is important to scholarship decisions or other coaching decisions.

FIGURE (6)

In Fig. (6) we show the RPI of the KIII theory beginning around September 2013 to April 2014. At this time the parents moved the student to a conventional program after a short transition period. The conventional program started in September 2014 and is still in progress at the time of this publication. In addition to this case, there have been several other cases where, for various reasons, the student had to transition to a conventional program with the same relative RPI results.

Of particular significance is that during the student's KIII training period we see steady improvement well beyond the expected. On the other hand, when the student returned to a conventional program, the RPI flat-lined.

FIGURE (7)

In Fig. (7) we show the RPI of for a short time duration student in the KIII theory beginning around June 2014 to the beginning of August 2014. At this time the parents, as with RH, moved the student to a conventional program. The conventional program started in August 2014 without a transition period and is still in progress at the time of this publication. Afer examinatio of several more cases, we are predicting that the KIII program will out perform conventional training by a significant margin. This prediction is illustrated in the bottom right of Fig. (7) where we predict that the conventional program will reflect slow but steady progress whereas the KIII program will produce very rapid progress.

If these results can be replicated in rehabilitation programs, this would mean that a rehabilitation program derived from the KIII theory could result is very significant improvements in every form of rehabilitation.

Of particular significance is that during the student's KIII training period we see steady improvement well beyond the expected. On the other hand, when the student returned to a conventional program, the RPI flat-lined.

8 Is Instantiation a Model for Answering Useful Scientific Questions about Human Dynamics?

The instantiation of the KIII Theory in a sport suggests that it may be possible to apply KIII Theory to many human enterprises. With regard to science, Instantiation may provide an avenue for the formulation of important questions about human performance that cannot be addresses in the laboratory. Some questions of interest are listed in Table 8.

- Direction for future formal experimentation
- Discrimination between two theoretical alternatives
- Supplementation of statistical psychological experiments
- Development of new protocols for human subject experiments
- Refinement of existing brain trauma rehabilitation protocols
- Experimentation with rehabilitation of criminal or addictive behaviors
- Discovery of unexpected dynamics (serendipity)

Table 8 Potential values of the KIII Sports Instantiation Project

Direction for future formal experimentation In the process of training tennis players, numerous questions arise: (1) What is the average time for learning a mesoscopic component? What is the variance? (2) What is the value of radical behaviorism in developing components? (3) Can poorly coordinated individuals develop improved coordination by focusing on component building? (4) What is the time differential in developing an entire stroke sequence from a template-based approach as compared to a component based approach?

(5) Human intellectual skills evolved from hominid physical, ”athletic”, activities in a chaotic and hostile environment. This suggests a relationship between skill development and intellectual development. In primeval environments there were no possibilities for formal learning. Hence, every advancement was by trial-and-error and an advancement must have proceeded first from learning simple activities, by chance, on which more complex activities were built. This is precisely how mathematics and the hard sciences developed. These observations raises the question ”Does component building enhance academic skills?” (6) If so, what is the relationship between component development and academic skill development?

(7) Can mesoscopic component formation be formally demonstrated by the KIII training program in conjunction with MRI studies? (8) Can mesoscopic component formation, and its formation progress, be verified by the change in EEG signals before and after training or at intervals during training; or, through spectral analysis? (9) Are component-based individuals more adaptable to new or continuously changing circumstances and challenges than template-based players?

Discriminations between two theories (1) Can Instantiation of two distinct theories offer insights into the development of laboratory procedures that can be used as formal proof of the validity of one theory over the other? (2) Can instantiation provide validation or discrimination between two competing theories?

Supplementation of Psychological Experiments (1) A pressing question in psychology is ”what is the impact of morale on mesoscopic component formation?” (2) Can Instantiation demonstrate that one theory of learning is more efficient than another?

Development of new protocols for human subject experiments Can instantiation guide in the development of more efficient protocols for human subject experimentation?

Refinement of existing brain trauma rehabilitation protocols (1) Can instantiation guide the development of new protocols for brain trauma rehabilitation? (2) Can Instantiation and training alter brain dynamics of criminals or drug addicts?

Experimentation with rehabilitation of criminal or addictive behaviors The KIII Theory, through its Instantiation as a training protocol, suggests that currently very difficult psychiatric problems may be approached in a new way. In particular, using the implication from the training program that change is far more likely than present empirical results suggest (e.g., 10% rehabilitation rate for drug addiction) a similar success may be achievable from a direct application of the KIII Theory to drug additions through Instantiation in the appropriate venue.

The use of Instantiation for the KIII Theory suggests that the KIII Theory best describes how human brains function by demonstrating that humans, with limitations, learn complex skills efficiently using an Instantiated training program based on the KIII model. Further research is needed to explore all the possibilities of Instantiation of the KIII model and other neurobiological theories generally.

Instantiation generally would proceed as follows: (1) Complete laboratory experiments to the fullest extent possible on non human brains or the brains of humans who have suffered a trauma and consent to the test. (2) Following maximum laboratory or medical confirmation, construct a sports training activity for normal humans based on the implications of the neurodynamical hypothesis to confirm that the hypothesis will extend from the laboratory to normal human activity.

It may be that the combination of laboratory confirmation combined with Instantiation may be the best possible avenue to confirm a neurodynamical theory of the ”normal” human brain.

9 Summary

In this paper we have demonstrated how to instantiate the KIII Theory in a tennis training venue which is a very simple model of a human system involving competition, stress, rapid development and complex decision making. The objective results on the USTA tournament Websites demonstrate that students who have come through this system compete very effectively against students that have been trained in conventional protocols and that even students with limitations have developed far faster than is possible using other systems. This would suggest that the

KIII Mesoscopic Wave-pulse Theory provides a very effective training protocol when translated into practice.

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11 References

[1] Boyd, R., Silk, J. [2009] *How Humans Evolved*, Fifth Edition, W.W. Norton, New York

[2] Freeman, W. J., [1999] *How Brains Make Up Their Minds* Weidenfeld & Nicholson, London

[3] Freeman, W.J., [2000] *Neurodynamics: An Exploration in Mesoscopic Brain Dynamics*, Springer, New York

[4] Donald, M [1991] *Origins of the Modern Mind*, Harvard University Press, Cambridge, Mass.

[5] Adey, R.,B irch, L., Lindsey, D., Maddox J., Olds, J., O'Neil, W.,[1972] *Brain Mechanisms and Control of Behavior* Heinemann Educational Books, Ltd., London

[6] Shepherd, D., [1994], *Neurobiology* Oxford University Press New York

[7] Kandel, E., Schwartz, J. and Jessell, T., [2000], *Principles of Neural Science*, 4/ed, McGraw Hill, New York

[8] Campbell, S.B., [1995] "Behavior problems in preschool children: A review of recent research", *Journal of Child Psychology and Psychiatry and Allied Disciplines* :36(1);113-149.

[9] Gibbons, A., [2009] A New Kind of Ancestor: Ardipithecus Unveiled, *Science* Vol. 326

[10] Izard, D. [2007] "Basic Emotion, Natural Kinds, Emotion Schema, and a New Paradigm" *Association for Psychological Science*, Vol. 2 No. 3.

[11] Dunstan, W. [1998], *The Ancient Near East*, Harcourt Brace, New York

[12] Coqueugnoit, H., Hublin, J., Veillon, F., Houet, F., Jacob, T., [2004], Early brain growth in Homo erectus and implications for cognitive ability, *Nature*, 431, 299-302

[13] Holloway, R. [1983], Human paleontological evidence relevant to language behavior, *Human Neurobiology*, 2, 105-114

[14] Sherwood, C. Subiaul, F., and Zawidzki, T., [2008] A Natural history of the human mind: tracing evolutionary changes in brain and cognition *J. Anatomical Society of Great Britain* 426-454

[15] Tobias, P. [1998]. Evidence for the Early Beginnings of Spoken Language. Cambridge Archaeological Journal, vol. 8, pp. 72-78.

[16] Fagan, B., [2010], *People of the Earth: An Introduction to World Prehistory* 12th/ ed

[17] Andersson, C., [2011], Paleolithic Punctuations and Equilibria: Did Retention Rather Than Invention Limit Technological Evolution? *Paleoanthropology*

[18] Mathews, G. G., [2001], *Neurobiology*, Blackwell Science, Malden, Mass.

[19] Gazzaniga, M., [2008] *Human* Harper Collins, New York

[20] Kyriacou, A. and Bruner, E., [2011] Brain Evolution, Innovation and Endocranial Variations in fossil Hominids *J. of Paleoanthropology* 130-143

[21] Renfrew, C., [2009] *Prehistory: The Making of the Human Mind* Random House, New York

[22] Coward, F., and Grove, M., [2011], Beyond the Tools: Social Innovation and Hominin Evolution *J. of Paleoanthropology* 111-129

[23] Field, R. [2009] *The Other Brain* Simon and Schuster, New York

[24] Verkhratsky, A., Butt, A., [2007] *Glial Neurobiology* Wiley, West Sussex, England

[25] Hammer, M., Woerner, A., Mendez, F., Watkins, J., Wall, J., [2011] Genetic evidence for archaic admixture in Africa, *PNAS* Vol. 108, No. 37

[26] Langer, E. [1985] *The Power of Mindful Learning*

[27] Freeman, W.J. [1995] *Societies of Brains* Lawrence Erlbaum Associates, Hove, U.K.

[28] Koob, A. [2009] *The Root of Thought* Pearson Education, Inc. New Jersey

Figure 1: Mesoscopic Component Analysis

Figure 2: MMA Conditioning

Figure 3: Standard Conditioning

Figure 4: Dan T. obstruction hydrocephalus due to tectal glioma

Figure 5: Jean V Sever damage to left Knee: Complete tear of the left knee PCL or Posterior Cruciate Ligament

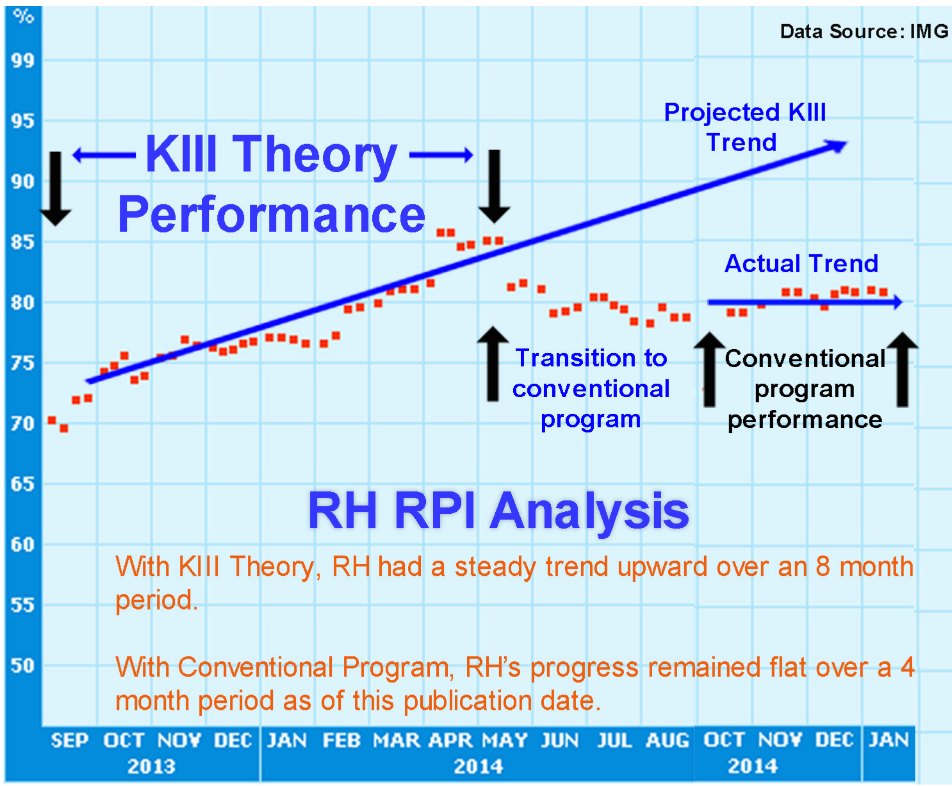

Figure 6: The RPI of RH comparing the KIII Theory progress to progress using Conventional Methods

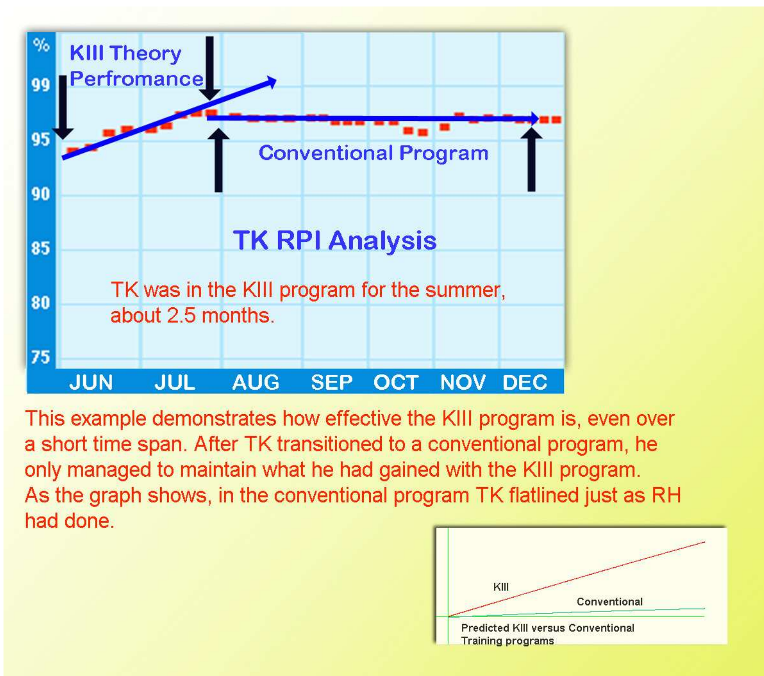

Figure 7: AK RPI for a short time span in the KIII program compared with that in a standard program