

Super-Learners in a Slow Motion World

The Neurophysics of Learning Disabilities and Information Disease

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Prologue

From the perspective of cognitive neurophysics, life is the exchange of information in the language of pattern. When information exchange ceases, life ceases. The human brain is not a “thing” it is an “event”. Its bio-architecture and behavior at any given moment is the result of the collective confluence of countless numbers of *event foci* (matter-energy vectors of restraint, having direction and momentum), which permit the development of certain types of highly concentrated, self-stabilizing, recurrent patterns of energy—“states of motion”—called attractors. The linking and un-linking of these attractors into phase paths permit the development of countless variations in human behavior.

“Mind” is *motion*, four-dimensional *patterns of force* which govern the exchange of information between biophysical processing substrates of brain and nature. Whenever there is a qualitative change in neurodynamics (the state of motion of the brain), there is always a corresponding change in the behaviors of mind. Brain bio-architecture is shaped and mind is organized by *process* not by *content*. Ergo, the matrix of genius is set in place by the systematic development of self-stabilizing information processing networks (stable energy structures) within the neurophysical/biophysical system, that permit information patterns, regardless of type (music, math, language, etc.), to be incorporated, replicated, cleaved, recombined, and transmitted.

What is Thinking and Learning?

According to the Standard Theory of Pattern-Entropy Dynamics (Furman and Gallo, 2000), thinking and learning is most appropriately thought of as the exchange of information (pattern) between processing substrates of the brain and *all* its connecting systems. The human brain, like all else in nature, continues to evolve as a pattern processing substrate, relentlessly being “customized” by the *information* (pattern) which it processes – the information it processes changes the structure, function and ultimate capability of the brain. With this in mind, the purpose of education and learning must be considered as the consistent, intentional evolution of the neurocognitive system toward a more efficient structure and function, so as to result in a qualitative change in neurodynamics and in greater capability for the human being.

Such a task cannot be accomplished when educators and the educational system focus on *content*, rather than *process*. Incontrovertible evidence suggests that the quality and quantity of content that is processed and utilized effectively by a human being, is both permitted and constrained by the process employed by the learner – by the human brain’s procedure for metabolizing complex patterns within its living bio-architecture.

In accordance with cognitive neurophysics and the Standard Theory of Pattern-Entropy Dynamics, the principle can be stated this way: “behavior” is a property of the *state of motion* of a system (the *pattern of forces* stabilizing and restricting the system). In neurophysics, behavior is understood as a product or the end result of a process. Let me give two examples so as to compare two very different systems subject to the same physical laws of nature.

The Atomic System - H₂O

Imagine before you a container in the shape of a cube filled with water. Water is considered to be the atomic system H₂O in its liquid *state* or *phase*. Each state or phase of a system is the result of a “state of motion” of its aggregate elements. This means that as the state of motion of the elements change, the state or phase of the system changes, either constraining or permitting certain types of collective behaviors to emerge. Imagine now that we change the phase of the H₂O system by lowering its temperature. What we have actually done is minimized the motion of the individual atoms in the system in such a way that they give into the attractive electromagnetic forces, hence becoming tightly packed. In this phase, where the state of motion has become minimized and the degrees of freedom of each of the individual atoms in the system has become restricted, new behaviors manifest, while other collective behaviors become impossible.

Let’s imagine that the cubicle container that holds the H₂O, now in its solid form, has a lattice on the bottom that would allow the molecules of H₂O to pass through. While the system maintains this state of motion we call “the solid phase,” “escape behavior” will be impossible. However, if we raise the temperature of the system (increase its energy flow), we will increase the speed of the individual atoms, as well as their degrees of freedom. The atoms will gradually break free from their tightly packed state and transition into the liquid phase we call water. From this qualitatively different state of motion, entire classes of behaviors are constrained while other classes of behavior are now permitted. The H₂O in its liquid state can now easily “escape” through the lattice at the bottom of the cube. However, we can no longer stack the H₂O into complex structures and carve it into elegant ice sculptures for tomorrow’s brunch.

If we now turn the cube upside down, leaving the lattice on the top of the cube, the H₂O, in its liquid state of motion, would no longer be able to perform escape behavior. Water cannot simply escape from the top without assistance. However, that behavior is available to the system in its “gas” phase. If we raise the temperature high enough, the H₂O system will become steam and as such, its atomic motion increases significantly while dramatically increasing the degrees of freedom of each individual element of the system. In its gas phase, H₂O can easily perform its escape behavior through the top lattice.

Behavior is a Property of the State of Motion of a System

Let’s restate the principle. All collective behaviors possible are in fact “properties” of the state of motion (phase) of a given system of elements. This means that *all behavior is state dependent* – if we want to change the behavior of a system, we must first change its state of motion and the desired behavior will follow as a natural consequence. Imagine

how silly one would seem trying to force a block of ice to escape from the bottom lattice of a cube without first changing its phase. This would be an enormous amount of work. One might think to take an axe or an ice pick and chop the ice into tiny pieces in order to force it through the lattice. Unfortunately this is the approach of most educators today – attempting to force information through processing circuits of the brain without first changing the state or phase of the neurocognitive system. When a physicist approaches the task of moving the H₂O through the bottom lattice of the cube, he simply increases the temperature of the system and then sits back in equanimity, observing the laws of nature as they permit the occurrence of the desired behavior. Because the physicist operates in alignment with nature’s fundamental principles, the results he gets appear magical.

The Neurocognitive System

The atomic system, H₂O, is a relatively simple system in physical terms since it is limited to only three distinctly different phases (solid, liquid and gas). The neurocognitive system, on the other hand, is enormously complex in that the states of motion possible seem almost infinite. The principle of state-dependent behavior is fundamental to nature. Regardless of complexity, this principle, as all other principles of physics, have illimitable dominion over all systems in nature – most important of which is the human brain (the neurocognitive system). Yet, instead of acting in alignment with this fundamental principle of nature, we instead approach education with axe and ice picks in hand – hoping to make the neurocognitive system do what we want by hitting it harder and harder. It is no wonder why children today are alienated by the educational process.

Let us look at a second example illustrating the ubiquity of state-dependent behavior in nature. One of the fundamental behaviors we require students to show a proclivity for is spelling. In the U.S., we judge the intelligence of an individual by how accurately they perform this behavior. While it is a relatively simple behavior for the neurocognitive system to perform, most students never learn to spell with great accuracy. The invention of spell-check is testament to the fact that within two weeks after a spelling test, the correct spelling of most words fail to be retrieved. Intelligent Learning Systems (ILS) remarkably eliminates this problem with a set of flash cards even a child can prepare (Furman, Dec. 1998). Let us examine how it utilizes this principle of neurophysics.

Aligning State, Phase or Mode with Desired Behavior

The first thing an Intelligent Learning System does is to examine the desired behavior in detail and determine what state, phase or mode (state of motion) would naturally produce this property or behavior. In the English language, nearly 2/3 of the words cannot be spelt phonetically (by sounding them out). This is evidenced by the enormous number of rules children must memorize to be able to apprehend the correct spelling of the word. Our standard educational system normally requires children to “memorize” these rules in addition to the phonetic “sound” of the words. If only phonetics is applied, and not the accompanying rules, it is possible to spell the word fish “ghoti” – that’s “gh” as in enough, “o” as in women (the plural form where “o” sounds like the short “i” sound), and “ti” as in attention (where the “ti” sounds like “sh”). This is certainly not the *only* way to

spell “fish” incorrectly. Quite paradoxically, even the word “phonics” can be spelt wrong in several ways using its own system, such as “fonix”.

The significant deviation from the behavior of correct spelling that most spelling systems permit and the rapid deterioration of memory traces, is clear evidence that the neurocognitive system is being guided into the wrong state for producing the desired behavior. When the right state, phase or mode is attained, the desired behavior becomes far more predictable and frequent with comparatively less effort. Correct spelling is important in two areas – reading (for identifying and recognizing word meanings) and writing (for accurately replicating word meanings). Both of these behaviors require a precise state of neurocognitive motion which is asymmetrically skewed toward the visual system. Neither reading nor writing requires an auditory mode of the neurocognitive system. Yet, the “spelling bee” is always conducted through an auditory-linguistic state of neurocognitive motion. The word is given to the contestant verbally and must be processed by the auditory system, and the contestant must give the answer verbally.

This exercise is futile because it is not in alignment with the state of motion of the neurocognitive system that must exist during reading or writing. Reading requires the neurocognitive system to recognize a set of symbols in visual mode and then to transform them into a spatio-temporal image (a movie). Writing requires the reverse state of motion of transforming spatio-temporal images into the symbolic, static, visual images we call words – albeit with the addition of transmitting the symbolic, visual information to motor pathways (writing). As we seriously evaluate how correct spelling will be used for the rest of a human being’s life, we clearly see that there are very few times where auditory phase/mode incorporation is applicable. The exception here might be in a context where we are studying lines to audition for a play or when we are performing dramatic readings in poetry.

Sweeping Problems Under the Carpet—Misleading Parents with Report Cards

This is certainly not what the education system means to prepare us for. Formal education must prepare students with foundational skills in such a way that these skills can be utilized by the students in the broadest number of contexts possible. Yet, if you look closely at most children’s report cards, their reading grade is commonly broken into two categories “reading” and “reading comprehension”. Since when do we consider a human being able to *read* when they are not able to *comprehend* what they read? This is a pernicious way of claiming educational progress when there is none to be found. When a reading grade is broken up into these two classifications, the word “reading” is simply another way of saying “pronunciation”. The educational system is merely conveying the fact that the student can *see* the word on a page and transform it into *sounds* in their auditory cortex and then finally into *articulatory motor* movements of the mouth. This is clearly *not* reading and is the main reason why parents get confused, asking educators the question “I hear my child reading but she doesn’t understand what she reads. How is this possible?” We simply are not aligning the state of the neurocognitive system with the resulting behavior we desire. To correct this problem for the behavior of spelling and to

bring that behavior in alignment with reading and writing, we must re-design educational process in such a way that it trains the brain of a child to transition to the appropriate state, phase or mode that naturally gives rise to the desired behavior. This is why an appropriate flash card system must be designed.

When a human being reads, they are incorporating symbols from the page, which are in actuality complex *patterns* of electromagnetic radiation (light and dark areas). These electromagnetic patterns are incorporated by one part of the visual system and must be compared with a similar pattern previously stored in another part of the visual system for “meaning or understanding” to occur. If the educator did not teach the student to “store” this symbolic pattern in visual mode, then in order for the brain to make the comparison, it must first replicate (remember) the phonetic pattern stored in auditory mode, and then transmit (translate) it to visual mode to be ready for comparison with the incoming information. This extra step causes numerous problems.

First, the conversion from auditory to visual mode can produce numerous mistakes as illustrated previously. Second, the amount of additional *time* necessary for the brain to switch from one state or phase to the next is enormous when seen in the context of a “timed” reading test. This is devastating to the student since in the U.S. and Europe we measure a student’s “intelligence” by their ability to *incorporate* and *replicate* information patterns within a given *time frame*. In the end, your grade does not depend on *what* you know, but how *fast* you know it.

This clumsy way of teaching content without regard for process also results in reading speed problems for adults. The auditory mode’s replication behavior causes translation of the words to articulatory motor circuits and subsequently prevents attempts to increase adult reading speed beyond 250 words per minute (the rate at which the words can be spoken sublingually). To break this barrier, adults must be taught to forget their old process of transforming visual, symbolic patterns into sounds in their head.

While I have given just a few illustrations of how the principle of state-dependent behavior is ignored to our detriment, a critical survey of the processes taught in our educational system will turn up thousands of such principle-based violations.

Thermodynamics, Energy Loss and the Human Brain

There is a hidden, serious side effect to the mismatching of state, phase or mode with desired behavior. The human brain, as it seeks to compensate for the mismatch, requires much more *time* to complete the behavior. The additional time and numbers of neurocognitive subsystems that must be brought to bear on the task, requires an enormous increase in energy reserve consumption within the brain and connecting systems. Considering the fact that this three-pound organ draws 25% of the body’s blood and energy supply, this is a serious violation of information processing efficiency. Why should learning and remembering make us physically tired? In actuality, it does so only when the process is sloppy.

The second law of thermodynamics teaches us that, at each *step* in a system's process, energy must be converted from usable (ordered) form to unusable (disordered) form. This is an irreversible transaction. What this means is that as we learn, our existing supply of available energy is irreversibly converted from usable to unusable form. The more steps a process requires, the more energy it transforms to an unusable state – a state of waste. Naturally the brain must tolerate this when a behavior actually does require several steps, but it is tragic when the additional steps in the process are absolutely not necessary to produce the behavior, i.e. spelling, reading and writing. The act of performing a behavior with the least number of energy transformation steps is called *elegance*.” Stated another way, a learning strategy is elegant when it requires the least number of *steps*, the least amount of *time* and the smallest amount of *energy* to perform. For students to enjoy the process of learning, it must *feel good* to learn. It must energize us, not make us exhausted. Transgression of this law results in a deleterious domino effect, seriously degrading the learning experience and adding unsuspected problems that the educational system must contend with.

ADHD, Hyperactivity and Thermodynamics

Why do students move so much in classrooms today that we have resorted to administering chemical straight-jackets like Ritalin and Adderall in order to keep classrooms from degrading into chaos? There are two very important reasons why students “move” while they learn.

Entropy and the Removal of Unusable Energy

First is the necessary removal of *unusable* energy from the neurocognitive system. As stated before, each step the brain must go through to produce a given behavior results in the irreversible conversion of energy from usable to unusable form. This unusable form is considered “waste” by the neurocognitive system and must be immediately dissipated (removed) from the system or it will cause damage. The human neurocognitive system removes (dissipates) this energy in *two* ways – by converting the waste to *thermal energy* (heat) and by converting the waste to *biomechanical energy* (movement). **Both heat and movement are waste products of the energy transformation process required for learning.** In fact, both thermal energy conversion (heat) and biomechanical energy conversion (movement) even occur during *perception*. If you have ever watched a long action movie, you may have noticed this phenomenon. By the time the movie is over, you feel quite hot and quite possibly you have also been perspiring. You may also have felt the insatiable urge to get up and stretch and take a walk.

This phenomenon can be readily observed even when seasoned graduate students conduct long study sessions in preparation for a test. It is an inescapable fact that the laws of thermodynamics predict that a system will remove unusable energy in direct proportion to the amount of unusable energy its transformation processes produce. The process of learning causes heat and movement within the neurocognitive system. When this movement is magnified by 36 students in a class, the chaos it produces is almost unimaginable. Teachers today find that they spend most of their time responding to the problems caused by excess movement and very little of their time actually teaching.

Chaotic Motion and Behavior Control Drugs

This excess movement amplified 36 times has caused such chaos in classrooms that more emphasis is placed on eliminating this movement than there is on proper teaching methods. By not clearly understanding the cause of this movement, we progressively worsen the problem. Today, one of the most common answers to the problem of hyperactivity is chemical dependency on “behavior control drugs” (Ritlin and Adderal). Both of these drugs are stimulants and produce only *temporary solutions* (increasing signal to noise ratio by way of NE modulation) while at the same time, causing *permanent damage* to the brain and connecting systems. A quick scan of the Physicians Desk Reference (PDR), will reveal a myriad of dangerous “side” effects that accompanies prolonged use of these chemical straight-jackets. The list of “do not use if” warnings include, but are not limited to, uncontrollable ticks, Torrett’s Syndrome, seizure activity and heart problems.

What happens if we are successful in stopping the movement of children in response to learning? **To the degree that we restrict the dissipation of unusable waste energy, we will degrade the learning process.** When a human brain incorporates a new “learning,” it most often must *forget* an old one. This means that in order for the brain to form the new electromagnetic and electrochemical pathways necessary to encode a learning, it must significantly *disrupt* the old ones. The human brain is doing this all the time. If it were not effective at this, you would move to your *new* home while continuing to give out your *old* phone number, and your *old* address. You may even find yourself driving to your old home.

Learning is Motion

In order for the brain to perform this task of updating collective “memory banks,” new electromagnetic patterns (learnings) must enter the brain with sufficient energy so that they may disrupt the existing atomic bonds which hold old pathways in place. To do this, the new pattern must engender enough energy not only to form a new self-stabilizing pattern (learning), but also to *disrupt* an existing electromagnetic and electrochemical pattern. After the new pattern is formed, if it is to remain stable and become a reliable memory, the additional, *unusable energy must be immediately removed from the system.* If it is not, the excess kinetic motion (jiggling) of the atomic bonds, will disrupt the self-stabilization process of the new pathways (new learning) just formed in the neurocognitive system.

In short, to the degree that we are successful in stopping children from *moving*, we will also be successful in stopping children from *learning*—like it or not, learning is motion. The fact that children can rarely take the same test two weeks later and still pass it, is evidence of the speed at which the neurocognitive system can degrade unstable patterns. Movement—the dissipation entropy—is absolutely necessary for stabilizing a new learning. The answer is not to eliminate it, but to channel it effectively back into the learning context; hence recycling a portion of the unusable waste energy. This is exactly what an Intelligent Learning System (ILS) does. Using carefully designed games, with different *degrees* of movement required, and by allowing children to *teach* others what

they have just learned, as well as taking frequent and carefully timed breaks, allows the effective dissipation and safe channeling of entropy (unusable energy).

***Compensating for Sensory-Motor Deprivation:
Effects Produced by the Absence or Restriction of Information Flow***

Removal of entropy from the neurocognitive system is *not* the only reason for the excessive amount of movement found in classrooms today. The dissipation of unusable energy is actually a *secondary* cause. The *first* cause is a dramatic mismatch between the *frequency* of the information flow in the classroom and the frequency of information incorporation a human brain is now capable of. This mismatch is more deleterious than you can possibly imagine.

Our rapidly complexifying world is producing brains (neurocognitive systems) that are forced to operate at ever increasing frequencies for longer and longer periods of time. From birth to age 5, a child's brain is sculpted by an enormous technologically-based increase in information flow. Children within this window of development, are wiring cortical information-processing pathways that will determine much of the structure and function of their brains for a lifetime. Today's children are exposed to multi-media television, multi-media, Pentium-speed computer systems, cellular phones, fax machines, messages that travel around the earth in seconds on the world-wide web, and video games that train hand/eye coordination at break-neck speeds, never normally encountered in their real living and learning environments, outside of cyberspace. Add to this high-frequency assault on the brain, a breakfast consisting of sugared cereals, jelly donuts and soda pop, and you have a neurocognitive system forced to operate at speeds that press the very edges of the human neurocognitive envelope.

Now imagine, 30-40 students per classroom with brains seeking to exchange and process information at this well-trained, accelerated baseline frequency. But wait, we haven't modified teaching environments in classrooms since the first school-houses were built—almost 200 years ago. Of course, we now use white boards and grease markers instead of blackboards and chalk. But our technological advancements in the classroom have stopped right about there. Those schools touting computer technology supply 1-2 computers per classroom for teachers and children to talk “about”, rather than learn “through”, as they sit in the back corners of classrooms awaiting repair.

The mismatch in the *speed of information flow* between the classroom environment and the neurocognitive environment, is devastating. One teacher with white board and grease marker in hand, cannot possibly move information fast enough to phase lock the attention circuits of 30-40 young, human brains, previously conditioned to process at break-neck speeds. This mismatch, if allowed to continue, leads to *information disease*. Such information disease has three origins: the *absence* or severe restriction of information patterns, the *excess* or overload of information flow and *conflict* between information patterns competing for finite spatio-temporal resources of the brain.

When a human brain is conditioned to process and exchange information at such high speeds as described before, the entrance into the school classroom environments

triggers an awkward feeling of being in a “slow-motion” world. While the first few minutes of this can be amusing, the negative effects on a child’s brain and the learning environment are profound. Engaging and maintaining attention becomes as difficult as a climb up Mount Everest.

Sensory-Motor Deprivation Causes Loss of Control over Attention and Thought Processes

As information flow becomes substantially restricted, the brain stem slows the frequency of its electro-magnetic messages to the cortex and connecting attention-engaging and disengaging circuits. The significant drop in brain stem, spike frequency lulls the cortex into a sleepy state, where *thoughts become disorganized*, concentration is broken and *attention is easily distracted*. If this mismatch continues for a significant period of time, the neurocognitive system has only two choices. It may self-compensate for the sensory-motor deprivation in order to maintain the minimum brain stem, spike frequency necessary to stay awake or it will fall asleep. Unfortunately, neither choice facilitates learning.

Without the proper amount of external information flow to stimulate the sensory cortices, the brain must compensate by using its own bio-mechanical energy to artificially generate the minimum amount of electro-magnetic activity necessary to stay awake. This is accomplished by continually increasing the frequency of movement until the necessary baseline rate is reached. As a result of this compensation, 30-40 children begin to fidget, stretch, tap pencils, crumple paper, talk, make rhythmic movements with their feet, get up and walk around, throw things and continue to attempt any behavior that will feed a sufficient amount of proprioceptive system impulses back through the brain stem and cortex.

The Birth of Attention Deficit Disorder (ADD)

As teachers make futile attempts to *restrict* this necessary movement, the children become less able to maintain sufficient states of attention and vigilance. Since the teachers are unable to engage all of the sensory systems that their children learn with simultaneously, any sensory system left unengaged by the teacher’s presentation will automatically seek stimulation elsewhere. Children become easily distracted by anything going on in the classroom that can be sensed by any of their unengaged incorporation circuits. There is only one solution to this problem. Teachers must learn to construct their presentations in a fast-paced, highly stimulating way intentionally engaging all of the sensory systems their students perceive and learn with. This means dividing the children into smaller groups, creating fast-paced, learning games that channel various frequencies of movement, appointing those children who “talk too much” as team “teachers” for their group, and getting their hands on any fast-paced technology that they can drag into the classroom.

It is important to note here that *as* the frequency of information exchange between student and environment increases to match the brain’s requirements, excess movement decreases in direct proportion. When movement stops and attention is fixated on the presentation, this is a good indication that the frequency of information exchange is just

right. This phenomenon is seen nearly every day by parents that are confounded by the fact that their “behavior problem child” is capable of sitting *motionless* for hours in front of the livingroom television set. And yet, can’t pay attention for even a few minutes at a time when in school.

Excess and Conflict of Information Patterns

A long-held belief amongst educators and parents is that children have “attention spans” and that these periods of focus and concentration can be extended by force in the same way that we increase the strength of a muscle. Both of these ideas are incorrect. Children do not have attention spans. Nor do human brains of any age. Human brains have *attention cycles* and knowledge of this helps us to correctly adjust and time information exchange between brain and environment. An attention cycle is like the opening and closing of a window. The first part of the cycle that we call “paying attention,” is when the window is open and the brain is *incorporating* information from its environment. The second part of the cycle that we call “not paying attention” begins when the neuro-active chemicals that we use to *incorporate* with are exhausted and the nerve cells, which were involved in the incorporation of information, now must replenish these molecular messengers. This period is called *molecular replenishment*.

There is another more subtle attention cycle embedded within the first cycle. This occurs when newly incorporated patterns of information are being *replicated* and *transmitted* from first to second messenger and third messenger molecule systems within nerve cells. This process is used by the brain to self-stabilize ephemeral patterns so that they become long-term memories.

Information Exchange Must be Timed with Attention Cycle Windows

Information exchange between the teaching environment and the children must be timed with these cycles. If it is not, children can never learn to their potential. When a child “loses attention” during an information exchange, and this condition seems to persist for some time, the student has either exhausted the necessary supply of neuro-chemicals or is in the process of replicating and transmitting information between first, second and third molecular messenger systems of the brain in attempts to stabilize the memory of the new pattern. In either case, forcing in additional information during this time creates an excess of, as well as a conflict between, information patterns in the brain.

The presence of excess pattern generates an over abundance of molecular waste (entropy) that must be dissipated, resulting in exhaustion. The presence of conflicting patterns tends to cause interference in the integrity of both patterns which are competing for control of the same neural substrates. This means that when you force a child to learn something additional, beyond their natural window of attention (incorporation), that you risk not only the immediate loss or corruption of that information, but also the loss or corruption of the information you just previously taught him.

The answer to this is to learn to pay attention to the attention cycles of students. First, children should be grouped by their attention cycles. This makes it much easier to package information and time it correctly so that the maximum amount is incorporated

before the window closes. When the children enter the second part of the cycle, instead of fighting it and creating additional chaos, the teacher should employ the strategic use of games and breaks until the window opens again. Children that naturally enjoy talking, can be utilized as team leaders to help children who have longer incorporation phases of their attention cycle, and need to hear the information a second time. In this way, the team leader dissipates entropy by talking and teaching, and their dissipation of energy can be productively channeled into the packaging of additional information for the students whose “windows” are opened longer.

It is also important to note that when a window closes down in one sensory system, it often opens up in another. It is actually possible in practice, to take children who are said to have 3-5 minute attention “spans,” and mesmerizingly engage them in the act of information incorporation for 3 hours or more simply by cycling the presentation of information from one sensory system to another. These are just some of the creative ways in which Intelligent Learning Systems (ILS) “customize” the exchange of information between the learner and their environment.

References:

Furman, M. E. (1998). Intelligent Learning Systems: A Student-Centered Model for Reconstructing the Human Education System. *Anchor Point*, December, 21-29.

Furman, M. E. and Gallo, P. (In Press 2000). *The Neurophysics of Human Behavior: Explorations at the Interface of Brain, Mind, Behavior and Information*. Boca Raton, FL: CRC Press



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Mr. Furman is an internationally respected scientist, author and lecturer. By the age of 37 he and his pioneering work became the subject of historical, biographical record, reported within the pages of the 17th Edition of *Marquis' Who's Who in the World*, *Marquis' Who's Who in Medicine and Health Care* and the 5th Edition of *Marquis' Who's Who in Science and Engineering*. He is recognized world-wide for his significant contributions to the fields Cognitive-Neurophysics and Education Neuroscience, his prolific published works and international public speaking. He is the developer of *Human Performance Modeling and Engineering*, *Intelligent Learning Systems (ILS)* and *NeuroPrint*—the first mind-

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Furman has recently completed his second book entitled *The Neurophysics of Human Behavior: Explorations at the Interface of Brain, Mind, Behavior and Information*, which was released in June of 2000. He has lectured both in the U.S. and Europe and his pioneering work in the field of neuroscience has been published in 42 countries. Furman is certified by The Society of NLP as a practitioner, he is also a member of The New York Academy of Sciences, The Cognitive Science Society, The American Society for Training and Development (ASTD), and The American Association for the Advancement of Science (AAAS). Mr. Furman has been a featured guest on several radio talk shows and his work has been the subject of a numerous feature interviews and articles appearing in national business journals. Mr. Furman is an affiliate

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