1997

Higher processing skills through multisensory perceptual stress awareness for improved concentration in reading and learning

Fay Tanaka
Pacific University

Higher processing skills through multisensory perceptual stress awareness for improved concentration in reading and learning

Abstract

This project investigates a new model in multisensory perceptual stress awareness, that incorporates performance enhancement training, and its effect on learning skills such as reading. A case report of a student utilizing a technique that expands his multisensory perceptual awareness is presented. The positive impact on academic performance is discussed.

Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

Anita McClain

Subject Categories

Optometry

HIGHER PROCESSING SKILLS THROUGH MULTISENSORY PERCEPTUAL STRESS AWARENESS FOR IMPROVED CONCENTRATION IN READING AND LEARNING

PRESENTED BY:

Fay Tanaka

In partial fulfillment for the Master of Education,
Visual Function in Learning

COMMITTEE MEMBERS:

Anita McClain

Hannu Laukkanen

HIGHER PROCESSING SKILLS THROUGH MULTISENSORY PERCEPTUAL STRESS AWARENESS FOR IMPROVED CONCENTRATION IN READING AND LEARNING

OPT. 995

FAY M. TANAKA O.D.

Abstract: This project investigates a new model in multisensory perceptual stress awareness, that incorporates performance enhancement training, and its effect on learning skills such as reading. A case report of a student utilizing a technique that expands his multisensory perceptual awareness is presented. The positive impact on academic performance is discussed.

TABLE OF CONTENTS

"Any successful learning theory must capture the mechanics of learning in both environmental and biological terms." p. 177
Pressley and McCormick

I. INTRODUCTION

There are thousands of children with learning disorders who are enrolled in remediation programs to address their deficits in learning skills. Unfortunately, it is not clear why there are so many who do not benefit from these programs. It is important to investigate why this is so and research new forms of remediation. It is for this reason this thesis explores a relatively new approach in remediation for the learning disabled population. This thesis presents a multisensory perceptual stress case study, including theoretical underpinnings, supportive research, along with supportive and conflicting theories.

Multisensory perceptual stress awareness is an empirical construct that heightens the acquisition of perception of all sensorial modalities through the use of a positive form of stress. In order for learning to take place, information must first be fueled in some fashion into our brain to be processed interpreted and stored. Information is initially received through our various senses primarily through vision, hearing and proprioception. When receiving new information through one of those sensory modalities, a certain amount of effort must be expended to some degree to allow for interpretation, processing and storage to take place. If too much effort is required to complete such a task, a heightened level of distress could be created beyond the level of productivity resulting in learning deficiencies. Multisensory perceptual stress

awareness aims to enhance cognitive capacity with the application of stress to expand receptive channels for clearer receptive processing towards effortless efficiency in performance.

These receptive channels within our brains or synaptic bridges link incoming information to our cognitive centers. They must first be developed in order for information to be properly received and interpreted. Greenough and Juraska(1986) termed such synapses, experience-dependent synapses (as quoted in Pressley and McCormick,1995) When an unexpected experience or environmental stimuli as in the form of stress is introduced to an individual, neurons are activated and synaptic connections are established. These synaptic bridges must then be constructed well to avoid slow and laborious interpretive processing or eventually they will die off.

Many of us have experienced attempting to concentrate on reading a document or manuscript and find ourselves unable to do so. For example, perhaps there was a time you were unaware that your mind was wandering, distracted by a conversation taking place next to you or bothered by the draft of the air conditioning overhead and realized five minutes later that you're still on the same paragraph. Or maybe you've experienced pushing yourself to read an article, but with extraneous effort to sustain comprehension. All these experiences are in nature addressing visual attention and awareness. How we are able to effectively learn to control thoughts and actions to attend to a particular task is a key to efficiently process information.

To b^ exceptionally attentive(aware), there is a need to grasp attention in its entirety, to be continually aware of and attuned to sensory and mental activities. This addresses not only awareness of our thoughts but also perception of kinesthesiology, visual, auditory, tactile and

somatosensory information that is present all around us, as subtle as it might be, at all times. In grasping this awareness, we can then choose to subdue, divert or direct extraneous thoughts and movements at any moment. For example, in the event there is a particular area that needs to be addressed, for instance a binocular dysfunction, once aware of this, it can be worked on as well. In diverting extraneous thoughts, a clear uninhibited pathway is created to focus more effectively on task. This concept of awareness, or multisensory perceptual awareness enhanced with the proper use of stress may prove a valuable asset to optimal task performance and particularly while reading.

The following sections will address the concept of awareness as it applies to multisensory perceptual awareness, the key role that stress plays in multisensory awareness and how they all tie in together to enhance the reading process. I would also like to touch upon neurological studies supporting the data that exclusive neuronal behavior exists suggestive of multisensory perceptual activity registering in certain areas of the brain. The last section of this paper will present a case report utilizing the multisensory perceptual stress model.

II. ATTENTION VS. AWARENESS

"Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence." William James(1980)

Was William James referring to attention or awareness? This next section on attention and awareness will help to clarify their differences.

There has been much research in the area of attention and particularly "divided attention." To determine the human potential in attending to multiple tasks simultaneously, it has been found that in general, people respond faster to multiple tasks presented simultaneously verses a single task presented independently (Selye, 1975). However, it has been found that on average, the most we can attend to at the same time are to two tasks This is refutable. Attention is very limited to the particular task/s at hand. In contrast, Awareness involves the expansion of our senses above and beyond the particular tasks attended to. The effort to block out environmental distractions aren't necessary when you are already aware of them. Therefore, the absence of strenuous effort or stress to block out such distractions allows for a more effortless ease to focus on a particular task or tasks. The process of reading itself involves various bodily functions simultaneously. The eyes must focus, converge, and move along the printed page while the brain is registering the information being read. We mustn't forget that our autonomic nervous system is still at work as we are still breathing, our hearts are still pumping, and our many fine elongated muscle fibers of the vertebrae are working together to keep our posture upright on our seats. An efficient reader is able to tune out these extraneous distractions with undivided "attention." But an even more efficient reader is "aware" of the surrounding distractions and thus requires no effort to tune out these extraneous distractions while reading (Marcel, 1983).

III. DEFINITION OF STRESS

Stress often carries a reputation associated with an undesirable emotion to be avoided. Ambiguous in meaning perhaps because of its reputation as a villainous character when referring to the detrimental effect it can have upon peoples lives, stress is also a necessary part of the growth and existence of life. Unaware if I may be a proponent of

the underdog, I feel compelled to dust off and reveal the true nature of what stress is.

"Stress" in a pathological or oncological application refers to the demand upon a cell of an organ or tissue to adapt to a new situation or level of functioning. This adaptation of the cell is an ongoing process necessary for homeostasis to occur to keep the cell in equilibrium with its environment. If the level of stress goes beyond the cell's ability to adapt, the cell is unable to function efficiently and becomes compromised leading to cell malfunction, disorder, inefficiency or death to the cell (Wallace, 1986). If this is compared to the visual system, cell injury, malfunction or disorder can, in retrospect, be analogous to myopia or strabismus. Cell inefficiency may represent a binocular deficiency. Death may relate to the absolute avoidance of performance altogether (Forrest, 1988). Therefore, in order to maintain homeostasis with consideration to that of stress, it must be present to some degree, but not to a degree that is perceptively excessive, destructive or inhibiting for growth.

From an optometric viewpoint, stress has a substantial influence in visual function. Most often this influence of stress is not viewed quite so favorably. As a founding theorist in behavioral optometry, the late A.M. Skeffington O.D.(1950) best summarizes visual stress as, "...the biologically unacceptable, socially compulsive, visually near-centered task which provokes an avoidance reaction...that becomes a drive to center nearer in visual space." The result of this visual stress then leads to refractive (nearsightedness, astigmatism, etc..) and/or oculomotor problems (such as eye turns, suppression, convergence insufficiency, convergence excess, accommodative insufficiency, infacility, or hysteresis and a gamut of others) manifesting in asthenoptic symptoms, eyestrain, loss of depth perception, blurriness and/or double vision, for

the individual addressing a visually demanding near task. Therefore, vision as it relates to stress is a dynamic process involving the individual and her or his environment. Ultimately visual stress reveals itself by increased tension, inefficiency, frustration or avoidance from a reading task.

From a perspective background of psychology comes a more diplomatic view. The environment can be a source of "stress" if an individual responds to it as a stressor. Another individual in the same environment may not respond to his or her environment in the same way. It becomes a physiological response culminated by an individual's personal perspective of his environmental situation. In light of semantics, stress may allow for the flow of growth rather than impede it. This brings us closer to a more positive definition synonymous to that of "EUSTRESS" which acts as a initiator for productivity. "Eu" is a Greek derivative meaning "good." It was Hans Selye who first introduced this word to clarify the existence of certain stressors as being essential to the existence of life. According to Elliot Forrest(1988), stress in this context is uplifting, pleasureful and constructive. He further refers to "eustress" as the degree of productive force where "health, performance and general well-being remain positive." Stress of this form is used interchangeably with "eustress" as it is used in the concept of Multisensory Perceptual Stress. This paper supports this definition of stress most favorably and therefore, in future context when mentioning the word "stress," as implied with multisensory perceptual stress, it is "eustress" that is being referred to.

We all know of individuals who rise to the challenge and thrive under pressure. Olympic athletes often fall into this category. Somehow they are able to convert this pressure or "eustress" into adrenaline that opens the floodgates for a burst of positive energy that elevates them into a higher state of functioning. Many of these athletes

describes this feeling as a natural high or mental state of clarity and awareness of uninhibited physical capabilities in their present environment. "Stress" is more accurately "eustress" to these exceptional individuals on such occasions. In understanding the physiological response which takes place among these athletes, perhaps a connection to the physiology of learning can be found. When a stressor is introduced, a part of the brain, the hypothalamus, activates hormones and neurotransmitters, which are biochemicals or adrenaline, to be secreted by the endocrine system and nervous system. Nucleotides or AMPs (adenosine monophosphates) are then released into the system affecting bodily functions such as air passage size, blood vessel size, heart rate, growth, and several other processes. The neuroendocrine system allows for adaptation to the stressor for maintaining function at high levels of stress arousal (Forrest,1988).

Perhaps just as this concept of "eustress" applies to an athlete it can also be applied to a student. Which thus brings us to education and its viewpoint on how stress plays a part in the process of learning.

Much reference to stress in the classroom is viewed as detrimental to a learning environment. Advice on stress reduction strategies or eliminating stressful conditions for students are often a subject of concern for teaching instructors. Stress often seems to be placed in the category of anxiety and therefore is quickly something to be avoided. With a better understanding of how stress may play a positive part in learning, placing more value in its benefits may provide added insight to a more productive and innovative classroom ambiance. Later in this paper, I will introduce studies in education that are showing this change towards a more positive understanding of stress.

I'd like to briefly introduce the general view of multisensory perceptual stress. Multisensory perceptual stress provides an environment rich in stimulation for all senses. The provocation of sensation is conducive for alertness and interest for a child, or student. Stimulating tasks that are challenging, demanding but not excessively stressful are thereby a conduit for intellectual growth.

Learning takes place when a child is given the opportunity to stretch his or her skills allowing for growth in knowledge so that tasks and goals may be attained. Through accomplishment of goals, a child builds confidence in his or her skills so that more challenges are welcomed. Herein lies a continuum for growth through learning. See Figure A.

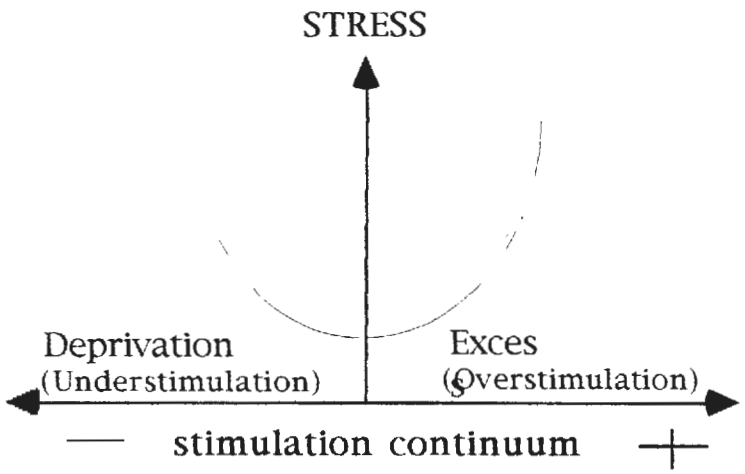

FIG. A STRESS AND VISION, 1988

IV. MULTISENSORY PERCEPTUAL STRESS AWARENESS

The concept of multisensory perceptual stress awareness or MPSA is based on the enhancement of the cognitive capacity to function in the least restrictive condition for effortless efficiency.

A. Multisensory Integration : Open Focus

Much of the stress that we create in our lives is dependent on how we view our environment. We may take a global organizational perspective or a detailed organizational view of our environment to problem solve and conceptualize ideas. Our social environment, however, predisposes us to orient ourselves on near-centered tasks such as reading and writing which comprise about 90% of a students school workload. Therefore, we physiologically follow along to constrict our peripheral environment perceptually in order to function at a near point. As we become more focused in attention to detail or "figures", we become less attuned to the surrounding global view or "ground." This figure-ground concept of thinking poses a dichotomy whereby in functioning one way, we would inhibit or surrender the attention to the other channel of input. (Forrest, 1988) This could be exemplified physiologically with the manifestation of myopes (near sighted individuals) whose interest is enforcing concentration to be entirely centered upon the "figure" while they tune out the "ground" in order to prevent distracting peripheral stimuli from cluttering their thoughts. Such individuals physiologically adapt to this by becoming nearsighted. An example of this is with higher achieving individuals. Their daily activities primarily involve near centered tasks such as studying. This "figure/ground" concept is substantiated with studies showing the incidence of myopia escalating among high stressed college students (Lin, 1995).

This absolute selectivity of the "figure" can translate to other physiological manifestations such as with the eye condition known as esophoria verses exophoria. An esophoric individual postures his eyes inward, closer than a certain point of attentional regard. The exophore wants

maximum information from all areas in space either centrally or peripherally and postures his eyes farther outward from a point of regard in order to gather information all around him. The anatomical construct of the eye provides a neurological explanation for the exophoric/esophoric manifestations. The area of the retina where vision is clearest is located at the fovea. It is at this point where there is a one to one ratio of receptor cells(cones) hooked up to bipolar and ganglion cells. All other parts of the retina which takes in peripheral cues consists of many receptor cells(rods) which share the transmission unit of a single bipolar cell which also shares with many other bipolar cells a single ganglion cell. Therefore central information processing neurologically out performs peripheral processing and therefore is dominant and difficult to tune out. The exophore prefers to take in information peripherally but also is confronted by central incoming information and therefore bounces back and forth from central to peripheral cues (Forrest, 1988).

A highly exophoric individual constantly struggles between two channels of information gathering and often finds it hard to stay on task. The high esophore is limited in intake of information, initially fighting to stay focused exclusively on a focal task. Eventually, this esophore adapts to the central or limited processing style. It may be a contributing factor that the onset of myopia manifests itself in a esophoric posture. For optimal processing to take place, a simultaneous combination of both processing styles must be attained. The key is simultaneity. Such an integration would effectuate a form of processing in both central and peripheral styles termed "open focus"(Forrest, 1988).

The idea of open focus would be to expand an individual's awareness to all perceptual sensory modalities. The gustatory, tactile, olfactory, sight, kinesthetic, and

auditory information centers must all be integrated and organized perceptually rather than isolated. For example, when reading, vision is not the sole stimulus channel by which information is being gathered. Articulatory as well as auditory channels are also being tapped. Physiology also influences the ease of the reading process such as poor posture or an inappropriate working distance may it be five to ten inches from head to text material. When we attempt to block out other sensory inputs, extra stress and energy is expended to do so. (Lorch-Bacci, 1993). This results in inflexibility and a developed habitual response of continually blocking out other sensory inputs. This contributes to mental inflexibility in just about every act of meaningful action from speaking, reading to thinking.

This habitual act of blocking out extraneous stimuli is contrasted to what Dr. Elliott Forrest terms "inclusive concentration."(Forrest, 1988). He explains that with inclusive concentration, the learning experience eliminates the excess stress needed to tune out the entire field of experience. The individual completely accepts the information from all sense modalities to be perceived for an expanded state of awareness for the present task at hand. This encourages physiological relaxation and mental acuteness. The actual processing of information involves a corresponding feedback system between mostly the motoric, auditory and visual systems (Grosser, Stone. 1986).

B. Over Load Principle

When too much information is given at one time to an individual whose sensory organization and integration ability is inefficient, this individual's processing abilities falter. When the sensory pathways become overloaded with information, this individual's ability to perform is compromised. With an increased awareness of perceptual skills through intensive multisensorial stimulation an

individual can slowly learn to adapt to higher and higher levels of perceptual stimuli by which to function and process (Pepper, 1986).

In some forms of martial arts, rigorous physical and mental stamina is emphasized for peak performance for combat purposes. The overload principle is often practiced during training. Methods of building their mental and physical durability is the core of their discipline. Nei Kung or "internal work" is training of certain body parts such as the stomach, kidneys and tendons which are not normally under conscious control. As an example of how it is applied is presented in the art form of Tai Chi. A particular exercise referred to as "standing" is taken. Your posture, arms and legs are all held in a certain position for a lengthy period of time as directed by the instructor. If done correctly, the student's leg strength will eventually give way to shaking. At this point, in order to maintain the appropriate posture, breathing rhythm, and stability during this period of intense stress on the physical body, the mind must remain clear, acute and aware of all musculature and the surrounding environment while rising above the physical stress in order to maintain the standing position. Keeping the mind on task in such a position for an indefinite period of time expands mental awareness and endurance for the whole body targeting both the autonomic and central nervous systems (Sigman, 1993).

C. Mave Stress Training

Dr. Robert C. Pepper developed a training program to help athletes improve their mental stamina by fine tuning their alertness in pressure situations. He advocates a Movement, Auditory, Visual , Enhancement Stress Training technique referred to as MAVE Stress Training. It aims to extend the "operational level and range" by developing performance during stress conditions, below the "frustration

level." It centers on refinement of gross and fine motor responses, time and space sequencing, memory and pattern recognition, increased attention span, figure-ground organization, and centering. The organization of all these various sources of information must then be dealt with at the same time (Pepper, 1986).

D. Dr. Tabb's Perceptual Stress Therapy

Although Dr. Pepper has retired, most of his methods have been incorporated into Dr. Roger Tabb's theory of Perceptual Stress Therapy (PST). Dr. Tabb began practicing PST in 1966 in Fort Collins, Colorado. He has geared PST toward higher organizational levels of integration between various sensory pathways so that perceptual processing (may it be visual, auditory, gustatory, or kinesthetic) allows for efficient effortless performance on whatever task may be at hand. The level of each sense modality that the individual is capable of functioning at is first determined then trained to a higher and higher level with integration of the various senses. This creates an enhancement in concentration and awareness to effectively deal with various stimuli present at any one moment. With a thorough vision and visual-perceptual analysis, Dr. Tabb decides which patients are candidates for PST.

V. SUPPORTIVE THEORIES IN COGNITIVE DEVELOPMENT

A. Dual Coding (DC)

Dual coding is a well accepted theory in information processing and may be a prefatory form of a multisensory perceptual stress awareness theory. The general view of dual coding(DC) is that cognition occurs by the activity of several representation systems that specializes in dealing with various environmental stimuli. The stimuli can be

visual, tactile, auditory or kinesthetic. The human cognitive functions are capable of registering all these stimuli simultaneously.

There are two major subsystems consisting of a language and a nonverbal or imagery based subsystem. Both subsystems have distinct functions and structures yet can work in unison or independent of one another. They are able to organize, monopolize, or retrieve information from one another to make sense of incoming information.(Paivio,1990)

Much like dual coding, multisensory perceptual awareness is the ability to take in information simultaneously from many sources. However, rather than two subsystems, multisensory perceptual awareness allows information to be easily received from many different subsystems of visual, auditory, kinesthetic, tactile and gustatory origins.

B. Strategy Competition Module: CEO of a "Smarter" Model

The concept of working memory as the locus of processing information during a certain mentally challenging activity is similar to the working space of awareness in MPSA. This model suggests that working memory is responsive to fluctuating levels of difficulty in comprehension during the activity of text reading. Within working memory resources, new incoming information is monitored and evaluated, shifting priorities to meet demands of comprehension. This process allows for flexibility in comprehension within working memory. This flexibility deals with topic change, importance, relevance and a global organization to achieve coherence of material presented in text (Britton, Graesser, 1996).

As the strategy competition module works to increase the flexibility of working memory, multisensory perceptual

awareness also aims to achieve the flexibility in awareness through the application of stress to allow for the ease of comprehension of new learning material whatever the demand may be. The more complex the demands on cognition through the application of stress, the higher the skill level must become to continue the cognitive processes of learning.

C. Working Memory

Just and Carpenter (1992) defined working memory as storage and processing of computational thought such as retrieval, comparison, and logic. The maximum amount of activated processes occurring within working memory is its capacity. The capacity within the working memory is limited by the amount of activated information that can be processed simultaneously.

Just and Carpenter (1992) acknowledged the central role that working memory plays in language comprehension. In studies they had conducted, they found that capacity of working memory varies among individuals. Individuals with a larger capacity were able to draw on a larger resource base for better processing for comprehension. They found that both operational processing as well as storage of resource information constitutes working memory. But what stirs cognition for comprehension within working memory is the demand or activation of both its stored information resources and its processing functions. This demand similarly resembles the form of stress encouraged in MPSA.

Daneman and Carpenter (1980) conducted studies with results showing readers with higher working memory capacities were able to retain active information for longer periods. Their experiments aimed at measuring a readers ability to maintain information within working memory. Antecedents and its correlated pronoun were separated by several sentences. The maximum text distance a reader could identify an

antecedent to its pronoun measured this readers working memory capacity.

Just and King (1991) conducted several studies which found that individuals with larger working memory capacity as measured through a Reading Span Task[1], were both faster and more accurate in comprehension of more complex reading tasks. Their method of testing comprehension was through the use of "center embedded object clauses" which are syntactic structures that are particularly demanding on working memory. An example of this was given as follows: "The reporter that the senator attacked admitted the error." This would in comparison be more difficult than reading a subject-relative clause such as, "The reporter that attacked the senator admitted the error." Using such syntactic structures, they were able to isolate working memory capacity differences among high and low processing skills.

In comparing MPSA to working memory, each retains workable information held in an active state in the cognitive processing center and is clear and ready to be processed. The high capacity of awareness and working memory allows for immediate more efficient processing.

D. Zone Of Proximal Development

Lev Vygotsky (Pressley, McCormick, 1995) recognized that in teaching a child, an educator is most interested in

---

[1] In measuring working memory capacity, Daneman and Carpenter (1980) devised the Reading Span Task. It was designed to measure both processing and storage resources in working memory. Their experiments consisted of giving several sentences to a subject to read and remember. The subect was then asked to recall the last word of each sentence. The maximum number of sentences for which the subect recalls the last word is defined as this individual's reading span. High span individuals could recall four or more words correctly. Medium span ability displayed recall of three or on average three and a half words. Low span individuals recalled less than three words. Reading span task measurements were found to be highly correlated with verbal SAT scores (Daneman and Carpenter,1980, and Masson and Miller, 1983). Similar studies also found reading span highly correlated to comprehension skills (Just and Carpenter, 1992).

what children are most capable of. A goal of an educator is determining what the optimal potential of a child is. Developing the competence level of a child would involve encouraging the child to strive towards the upper boundaries of her or his capabilities (Sternberg, 1996). This view supports introducing a method to infuse a child towards achieving his or her potential. Using positive stress, as in multisensory perceptual stress awareness, would provide such an impetus to support the expansion of the upper limits of the Zone of Proximal Development.

E. Automatization

As an offshoot of Piaget's (1983) cognitive development, levels of information processing strategies may be viewed as a dependent variable of a child's attentional reserve. This concept is expressed in Case's theory on executive processing space(M space) and automatization. M space refers to the maximum amount of information that can be attended to at any one time. M space is often referred to as "working memory," much like that of working memory according to Just and Carpenter (1992). Automatization refers to the ability to use or process information automatically without much expended effort or attention. Automatization displays a close resemblance to the concept of awareness as referred to in the awareness achieved in MPSA.

When effort is present but to such a small amount that it no longer needs conscious attention (automatization), conscious attentional resources are then free to address more difficult matters where it is needed. This then follows a hierarchical organization where the extra attentional resources can thus be used to increase the next level of M space. There are similarities with this theory and a heterarchical organization as expressed in Minsky's society of mind concept (1986) which I will discuss shortly.

The most challenging intellectual task with practice can become automatic. Logan (1990) found that the amount of experience with a stimuli, allows for a response to be automatic without much effort and with accuracy. Logan would give computational tasks that requires laborious effort for a very young child, such as 6+9, 3+5, and other such pairs of single digit addition problems. Initially, a mental computational race would outdo a memory trace in figuring out such a problem. However with succession, a child would build a memory base that would outdo cognitive computation. This leads toward a direction of automaticity which makes the mind function quicker with less effort.

This concept of automaticity correlates closely with the process of how MPSA works. Learning new information becomes easier and more effortless. MPSA then takes this theory of automatization and expands it further. Rather than simply reacting automatically to stimuli by addressing it with less conscious attention, MPSA maintains the conscious attention of information within an active workable memory through a managerial system as explained in Minsky's society of mind (1986).

F. Minsky's Society Of Mind

Minsky's theory (1986) of intellectual development centers on a concept where a complex managerial system consisting of many organized agencies work together to become an intellectual unit. This complex managerial system orchestrates the various agencies' performance.

This managerial system is explained by Papert's principle (as quoted in Berninger, 1995), where 'conflict' brings growth to adjust to new situations by acquiring new skills and improved organizational systems of already existing skills (agency responsibilities). This then becomes a higher level administrative function for higher mental capacities. Herein lies a supportive theory behind the

concept of stress as it applies to MPSA. 'Conflict' closely resembles stress as it applies to MPSA in that it brings growth and the ability to attend more efficiently to new information through heightened skills and organized thought. See Figure B.

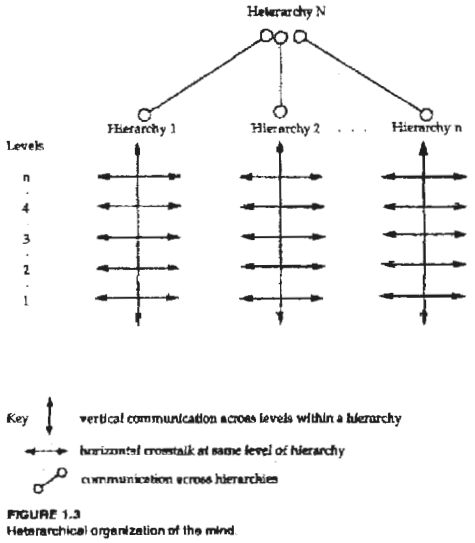

Figure B. Reading and Writing Acquisition, 1994

VI. PAST RESEARCH SUPPORTING MULTISENSORY PERCEPTUAL STRESS THEORY

A. Accelerated Reading Rate

Breznitz and Share (1992) conducted a study to measure reading comprehension with the added stress stimulus of manipulatively increasing the pace of reading and comparing this to self-paced reading. The finding demonstrated a substantial increase in accuracy and comprehension with fast paced reading. This supports MPSA with the added impetus of increasing demand of reading rate as a positive stressor for higher processing potential.

Breznitz and Share recruited 23 second graders in Haifa, Israel to take part in this study. Each student's natural self-paced reading rate was based on a series of

reading material given. Then each child was given the same reading tasks but to read at a 20% accelerated reading speed above their own individual best self-paced reading speed Different reading passages were projected on a screen and subjects were instructed to read aloud at either a self-paced or fast-paced reading rate. During the reading process, letters of each word were erased immediately after a word was read to prevent regression or re-reading. At the end of each passage, test questions were asked. Open ended questions were given to test for factual content, and multiple-choice inferential questions were given for recall and recognition of content.

Significant differences were obtained on reading accuracy, and four measures of comprehension. Reading accuracy increased by 48%, inferential comprehension by 21% and propositional recall improved by 29%.

The result of the study is fascinating. However, there are limitations. Small pool size of 22 subjects is hardly enough to warrant conclusions. Cultural differences cannot be generalized: children in Israel may participate with unique cultural activities which practices these tasks (e.g.. bible reading exercises) or their written language may be simpler than that of other languages. Also an unnatural environment for reading was provided where a child is to read aloud from a screen and forced not to regress. For these reasons it is questionable if the results can be repeated universally. But since methodology was clearly specified, and results were significantly repeatable at four fairly similar experiments with these children, replication of this study would be fairly easy and highly probable.

The major difference between self and fast paced reading was the added stress of 1. forcing the subjects to register word meanings quicker and 2. an increased dependence on memory span for comprehension. The subjects level of

processing improved since they were forced to read and comprehend the first and only time a phrase is presented. Therefore, stress did have a positive influence in reading comprehension and recall of these subjects.

B. Transfer Of Automaticity

According to Piagetian theory, reasoning ability is dependent on the development of the structure and nature of knowledge schemas. With such development, a level of processing ability is reached. The skills acquired to process at this level can then be used to reason and solve other problems of equal difficulty. The experiences or problems encountered are not as important as the process or force involved to rethink and mature in working out problems. The ability to transfer these skills to a wide variety of experiences thus marks maturational development(Sternberg, 1996). Case (1987), however, believed that the content of experience is critical and that transfer of cognitive skills happens only in specific problem domains.

A study by Kramer, Strayer and Buckley(1990) found that when automaticity of a skill is attained, the learning skill attained is not specific to the concept learned but rather to the process of higher level performance to complete the task. There is a transfer of automatic processing skills to tackle other tasks of similar high level learning. This is consistent with the outcome in a multisensory perceptual stress model where clarity of thought allows for the growth potential for higher processing strategies whatever task encountered. Although the data of this study showed the generality of learning had taken place beyond the skills they acquired, they did not analyze the specific nature of how such a process occurred.

C. Open Focus

Valdes(1988) conducted a study which found that Open Focus training exercises helped increase college student performance in school. Open focus attention training exercises consisted of utilization of a Electro-encephalograhic biofeedback (EEG) training device. It was used to help increase a state of attention that is "non-exclusive, tension-diffusing, non judgmental, and self-integrating."(Fehmi and Selzer, as quoted by Valdes(1988)). Subjects trained in open focus showed increased GPA, less stress-related symptoms, less anxiety, and improved management of emotional problems.

D. Flow Of Reading

According to a study completed by Csikszentmihalyi and Csikszentmihalyi(1988) "optimal experience" or "flow" is an experience with six characteristics which similarly corresponds to the MPSA model: (1) An individual is engaged in an activity which is challenging. This aspect of challenging is synonymous to a stressor or impetus as referred to in multisensory perceptual stress model. (2) The activity must have clear goals and feedback on performance. As in the MPSA, the mind requires clear thought and positive awareness of improvement in performance levels which also corresponds to the third characteristic. (3) The activity requires a focused concentration to a level where there exists a "merging of activity and awareness." (4) The individual feels in control of his or her activities. Much like the stress model, there is a feeling of ownership of one's capabilities when succeeding in a difficult task. (5) The sense of time becomes irrelevant. (6)Csikszentmihalyi quotes, "...At the most challenging levels, people actually report experiencing a <u>transcendence</u> of self, caused by the unusually high involvement with a system of action much more complex than what one usually encounters in everyday life." **See Figure 1.**

Two studies were conducted on the subject of flow. One consisted of children and adult pleasure readers and the other study involving 76 university students and professionals. The results found that the optimal experience or flow as described above, occurred in conjunction with the sensation of pleasure and interest in text material, and with texts that provided the reader with personal and intellectual benefits (McQuillan and Conde, 1996).

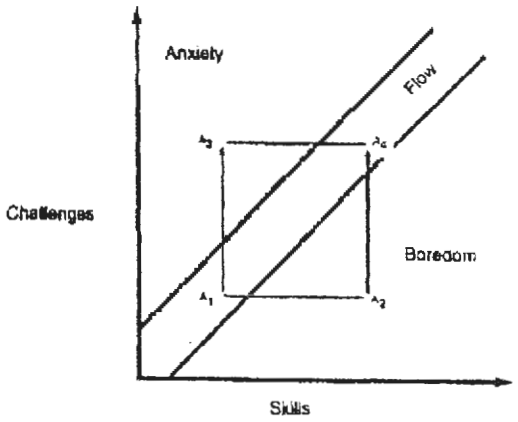

Figure 1. The conditions of Flow. [From Csikszentmihalyi (1988)]

E. Neurological Research and Theories

Neurological studies help to provide insight to the physiological activities that correspond to the theory behind the Multisensory perceptual stress model. Supportive research explains the existence of an anatomical neuronal network engineered for multisensory perceptual activities as described by several neurologists.

Visual, Auditory, and somatosensory influence have been found to converge at the superior colliculus where multisensory neurons are located (Wallace, 1993). The axons then exit the Superior Colliculus through descending pathways to the brain stem and spinal cord controlling orientation of eyes, ears and head. Studies done in divided attention have found this to be true (Miller, 1991). However, there are studies showing the existence of another circuit consisting of multisensory cortical neurons that do not project to the superior colliculus. The anatomical basis of their projection targets and afferent connections have not been determined (Wallace, 1993).

Studies were conducted to understand the neurological activities within the brain. Positron emission tomography (PET) scans, demonstrated that while reading single words, various brain structures are stimulated simultaneously (Berninger, 1994). The use of stimulating electrodes on various regions of the brain stem (of lab animals) was also another helpful method of isolating neuronal behavior. In determining the functional input the superior colliculus has on attention and orientation behavior, the electrodes demonstrated that neurons receive and integrates information from visual, auditory and somatosensory systems. A descending pathway of the superior colliculus, the tecto-reticulo spinal tract, has been found to play a major role in the orientation of eyes, ears and head. It was found that 84% of the activities of the tecto-reticulo spinal tract is

simultaneously multisensory in function (Meredith, Wallace, Stein, 1992).

Posner's orchestration of mind (Posner's et al., 1988) expresses a hybrid view that in order for these various structures to process together in a unified manner, the brain must be somehow organized to perform in such a manner. An English neurologist, Jackson(1887) proposed that mental processing should not be studied from its exact location of the brain, but rather from "the perspective of the level of construction in the nervous system." Luria(1973), and Kolb and Whishaw(1990) all agree that Jackson was ahead of his time in understanding cognition. Luria introduced neurodevelopmental concepts of cortical zones and functional units. The cortical zones consist of the primary projection areas which is modality specific such as visual or auditory, secondary association areas where information is synthesized, and tertiary association areas where input is integrated for abstract thought. The working brain has three functional units which are arousal, information processing, and programming and regulating. The arousal unit is subcortical, mostly involving the frontal lobe regulating arousal and responsiveness to environmental cues (RAS-reticular activating system). The information processing unit includes the occipital, temporal and parietal lobes unitarily which obtains, stores and processes information from environmental cues. The programming or regulating unit is the executive unit that monitors mental activities and thus abstract processing simultaneously (Berninger, 1994).

Cognitive neurologists often use positron-emission tomography (PET) and event-related potentials (ERP's) to map out areas of the brain involved with various tasks. Risto Naatanene(1988,1990,1992) along with colleagues Cowan, Winkler, Teder(1993), set out to determine if distraction prompted attentional responses recordable through PET and

ERP's. They found that dispite a deviant stimuli in the form of a high pitched auditory distracter, the brain showed brief responses without performance lag. This is suggestive that some type of analysis and selection occurs without disturbing attentional resources (Sternberg, 1995). Much like multisensory perceptual stress awareness, all incoming information, however distracting, is perceptually registered simultaneously. All receptive pathways are open to efficiently process at the same time.

This brings us to Minsky's society of mind theory of brain organization (Berninger, 1994) This theory states that the communication network of the brain consists of a vast society of agencies of sub-specialties interconnected with infinitely more agencies both directly and indirectly of many hierarchical levels of functioning. Each agency is virtually non directional until joined together with all agencies forming a whole functionally intellectual unit. A total state of mind allows for communication to all agents with awareness, as with multisensory perceptual awareness, of which some agents are active and others passive. The passive agents are not shut down but rather in check and not directly active with the task at hand.

VII. VIEWPOINTS CONTROVERSIAL WITH MULTISENSORY PERCEPTUAL STRESS MODEL

A. PRP Effect

In studying divided attention on tasks requiring rapid responses, Harold Pashler(1994) found that an individual is incapable of performing two cognitive tasks at once without showing a psychological refractory period or PRP effect. The PRP effect is a slowing down of performance on one or both tasks that are simultaneously attended to. He studied individuals performing two *extremely simple* overlapping (speeded) tasks (Sternberg, 1996).

The PRP effect contradicts the theory of multisensory perceptual awareness because it suggests that it is not possible to attend to two cognitive tasks simultaneously. Multisensory perceptual awareness is based on the principle that the brain is not only capable of attending to two simultaneous stimuli, but to multiple stimuli simultaneously.

B. Bottlenecks

This theory of information processing was first introduced by Braddant(1954). There are occasions when too much information must be cognitively processed at one time creating an overload or blockage. This event takes place at a "bottleneck" where the information gets backed up to a single channel where only one task or bit of information can be exclusively addressed at a time. This process channels in information singly since all information cannot be processed at the same time. The amount of information that gets channeled in for processing is dependent on the channel width of the bottleneck.(Reed, 1996)

Jong(1993) did a study on the model of the bottleneck in overlapping task performance. His results indicated that information from simultaneous tasks are separated or siphoned out to be addressed individually at the main or central bottleneck where actual perceptual processing takes place. Therefore, this theory explains that simultaneous tasks are not perceptually processed at the same time but rather at different parts of a selection process. This then contradicts a multisensory perceptual stress model and dual coding which supports simultaneous processing.

C. 3 Caps Model: Comprehension in a Capacity-Constrained Environment

Capacity-Constrained Construction Integration (Britton and Graesser, 1996) supports a similar view of text

comprehension processing as the multisensory perceptual stress model. The collaborative feature of the 3Caps model aims not at elimination of conflicting information but rather simultaneously processing them at different levels of activation. Information is matched to a certain category addressed at a certain level of processing. All of these simultaneous activations are occurring within the framework of the present working memory. The difference between multisensory perceptual stress and the 3Caps model lies in the limit that is placed upon the potential amount of information that can be addressed within the capacity of working memory. The limit is referred to as the "cap" of working memory space. When the cap is reached, irrelevant information not associated with elements in working memory are lost.

The view taken in multisensory perceptual stress is that there is no constraint or cap placed on working memory capacity. Since the goal of multisensory perceptual stress is the expansion of the working memory, the space of working memory is infinitely larger, much like that of a continuously extendible work table which allows all pieces of information to be laid out clearly for easy accessibility. This concept is supported by Goldman and Varma(1995) with their 3CI model (Britton, Graesser, 1995) explained earlier.

VIII. CONCLUSION

With so many different concepts and theories involved with the complexities of information processing it is impossible to synthesize them all into one cohesive framework to be prescribed as a panacea for learning problems. As with multisensory perceptual stress awareness, other theories also contribute valuable insights towards improved methods for

addressing the individual needs of each unique child with a learning problem.

Multisensory perceptual stress model as it pertains to reading and learning consist of three main goals: (1) Perceptual organization: Improvement in the integration between sensory modalities allows for more efficient processing and visual perception. When all sense modalities can work well together, a united orderly processing ability is acquired leading to enhanced attentional control. It is no longer necessary for all other modalities to be blocked out to avoid confusion since the information from other modalities is organized as needed. (2) Negative stress reduction: Allows for the reduction of stress while reading. Since there is less muscle tension to block out extraneous stimuli, more attentional energy can be channeled towards the reading process. (3) Control: The reader achieves an improved sense of control over the environment (better filtering of distractions as well as enhanced information acquisition from reading material) resulting in the environment controlling the reader less. This increases efficiency, speed and comprehension during the reading process.

I would like to conclude this thesis with a case report of a young student who enrolled in a Perceptual Stress Therapy (PST) program conducted by Dr. Roger Tabb. This case report is an example of a 16 year old male teenager who was doing poorly in school despite enrollment in several remedial programs. Four years prior to commencing Perceptual Stress Therapy he had his eyes examined by Dr. Roger Tabb who had informed him that his eye examination revealed that he would undoubtedly benefit from a program in PST. He chose not to enroll in the program at that time. After four more continuous years of poor scholastic achievement, with continued efforts at other remedial programs including basic vision therapy, he decided to give PST a try. He

participated in the PST program with Dr. Roger Tabb from September 6, 1994 to mid November, 1994.

IX. CASE REPORT

PATIENT: "LUCAS" AGE: 16 YEARS

HX: -BILATERAL DUANE'S SYNDROME

-SEVERE AUDITORY AND VISUAL COMPREHENSION DEFICITS

GOALS:

-Wants to become a pilot

-Gain the ability to comprehend auditory and visual information simultaneously

-Wants to do better in school (receiving D's and F's in school)

-Improve self confidence

-Improve athletic ability

Initial Workup (9/6/1994)

Lucas was given the Perceptual Visual Discrimination Skills test which measures his initial level of perceptual organization. It consists of forty cards of ten patterns measuring direction, size, space and form discrimination. Size pattern of a card may involve one, two or three parts larger or smaller than another part. The spatial pattern varies horizontally, vertically and diagonally. Form takes on one or two basic shapes. Direction is tested by

laterality changes on picture orientation of the card facing up, down, left, or right. It is a timed procedure whereby ten different patterns are placed in a double row, five on top and five on the bottom row. The remaining thirty cards are well shuffled. These cards must then be matched to its corresponding patterns as quickly and accurately as possible. Each of the ten cards are all very similar yet consists of very minute differences. To complete this requires a keen perception of direction, size, space and form. See figure 2.

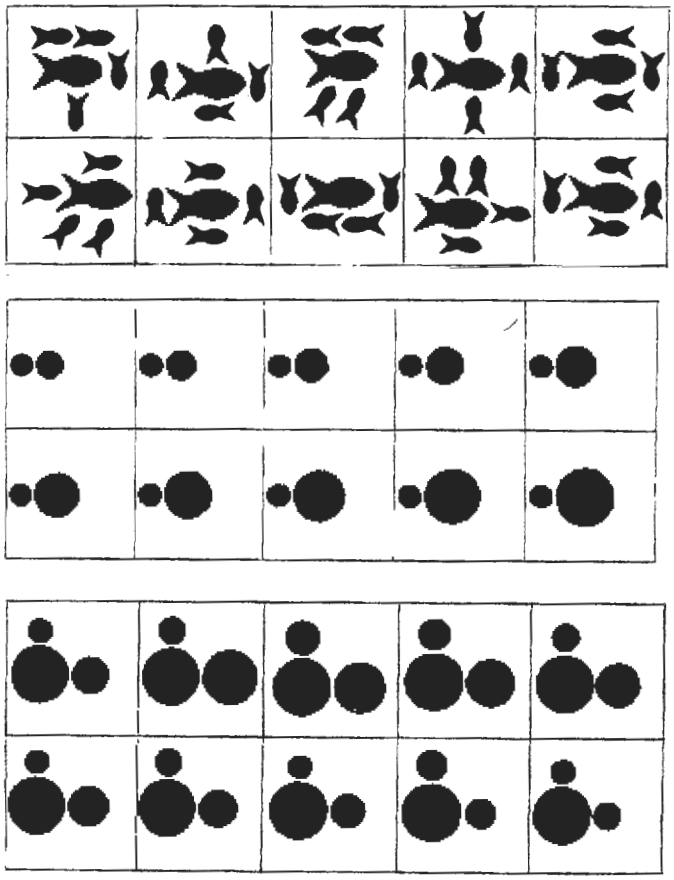

Figure 2. (Pepper Training Program, 1970)

Lucas rapidly completed this test. However, of the thirty possible correct placements, 20 were incorrect.

The Geo Board was also administered as a base line test. Lucas was unable to duplicate the first basic form and needed assistance to comprehend its directionality.

Blind tactile was also given for baseline ability. It took him 12 minutes and 10 seconds to complete all the pieces of the puzzle.

This concluded the PST evaluation. The results were used by Dr. Tabb to design the training program. The techniques used by Dr. Tabb to train Lucas are listed below.

PST Training Methods Used With Lucas

Various training devices and techniques are used at each perceptual stress therapy session. Each technique or device serves to stress emphasis on a certain sense modality and incorporates other sensory stimuli simultaneously. The following are descriptions of each:

I. Directional form board (geo board)

A nine square inch plastic board with long pegs placed evenly one inch apart is given to the patient. The therapist also has an identical replica. The therapist uses a long rubber band to create a figure by hooking it on to the pegs in a random fashion. The therapist then instructs the patient to do the same to his form board. Once the shape is correctly replicated, another set of instructions of increased difficulty is given. For example, the therapist will then instruct the patient to replicate the shape as it would appear if it had been rotated 90 degrees. If that was successfully completed, the therapist may then instruct the patient to replicate that shape as it would appear if the form board had been rotated 90 degrees, flipped upside down and reversed left for right. The instructions would continue to increase in difficulty until the patient is unable to successfully follow through with the directions given. The sense modality targeted is visual (visual spatial) with auditory peripheral stimulation and laterality.

II. Speed rotator

A circular peg board consisting of four rows of peg holes is situated upon a spinning rotator similar to that of a record player. The first row forms the inner most ring and the last row the outer most ring. The patient is instructed to place all the pegs into each hole and remove them. The rotation speed of the peg rotator is increased until the patient is unable to place a peg into the outermost row with repeated attempts. This would be considered the uppermost limit of this patient's present zone of proximal development. There are various auditory stimuli that are given to this patient to provide timed spaced coordination. The therapist may use a metronome to pace the consistency of peg placement either in a clockwise or counterclockwise fashion. Peg slots may be filled in double intervals (skipping 1 or 2 slots) as instructed by the therapist. All these tasks require auditory, tactile, visual, visual motor, and time space coordination simultaneously.

II. Blind tackle

The patient completes a puzzle either blind folded or with eyes shut. The time it takes to fit each piece of the puzzle is recorded. Tactile and spatial memory is stressed.

IV. Timed mental calisthenics on trampoline

Word phrases are first written on a chalkboard and memorized. The student must then say the first and last letter of the phrase and continue to the second and second to the last letter of that phrase until all letters of the phrase are said in the correct order. For example, "Chickens can fly" would be as follows: c,y,h,l,i,f,c,space,k,n, and so on. This process forces your working memory to expand with clarity. Visual memory is sharpened since the phrase is soon erased from the board. This task is performed on a trampoline. A metronome is necessary to pace jumping with

the calling of letters in the phrases. Kinesthesiology from jumping is a stressor as well as auditory input from the metronome. To heighten performance, metronome speed can be changed, and different tasks can be added (sitting or turning on all vowel letters, for example). All sensory modalities must be sharp and receptive at all times. Accomplishment of task is reached only when executed without errors.

Therapy Sessions (9/6/94- 10/20/94)

About 14 therapy days were spent with Lucas extending for a month and a half. Each therapy day met for an average of an hour and a half. Each session would begin with a discussion of concerns, improvements, shortcomings, and reiteration of goals. Then the therapist and student dive into intensive therapy exercises as described earlier in methodology. Trampoline, GEO Board, peg board, blind tactile and other similar challenging tasks were administered each time becoming more demanding according to Lucas's zone of development.

Lots of communication is fed back and forth between therapist and student during sessions. The student's metacognitive abilities are stressed while performing tasks and during breaks. The student's development in understanding his mental and physical actions during the process of learning the attended skills is encouraged by constant mental verbal feedback.

Results

Goals Lucas met were as follows:

1. Gained the ability to comprehend auditory and visual information simultaneously.

Prior to his therapy program, Lucas was unable to take notes while listening to a class lecture. He is now able to take notes during these same lectures with ease. He also finds himself attending and completing his homework quickly. Its usually the first thing he does when he gets home, which he says he has never done before. He is continually surprising himself with his efficiency.

2. School performance

Lucas was receiving two D's, one of them in algebra and all other classes he was failing. After commencing with therapy sessions he has found he is slowly able to organize his thoughts much better and focuses on all his school work much better. He has found that he can complete essay questions much faster than anyone else in class. He was able to complete an examination in 55 minutes rather than an hour and a half like the rest of the students. He "aced" that exam. His school report card had improved to 3 A's, B's and C's, no longer flunking any classes as before.

3. Increase his self confidence.

Clearer in thought processes and acuteness of his senses has Lucas feeling more relaxed and at ease with himself. He feels he has shed the anxiety of uncertainty in his abilities. The success at completing difficult tasks has given him the realization that he can transfer his successes to perform other tasks that may be unrelated yet equally difficult to do.

4. Improve athletic ability

Time sequencing, visual motor, and eye-hand coordination training has given Lucas the ability to play sports remarkably better. Having not played basketball in three months he noticed how quickly he was able to get his

timing back into the sport. It took him just 15 minutes when usually it takes him about 2 weeks to get back his timing.

5. The Perceptual Visual Discrimination Skills Test

This test was administered again to see Lucas's improvement in perceptual organization. In comparison to 20 errors on his initial attempt one month earlier, a substantial improvement to 8 errors proved most promising for further progress in performance.

6. GEO BOARD:

All three levels of difficulty of form task was completed without requested instruction. This shows marked improvement from the initial workup at which time the first level of difficulty could not be completed with assistance

7. Blind Tactile:

Lucas completed this in five minutes and 15.9 seconds showing little difficulty. This was a substantial improvement from his attempt of 12 minutes and 10 seconds at his initial workup.

Conclusion of Case Study

Lucas is one of many students who have been treated with perceptual stress therapy by Dr. Tabb. Some students require more time to acquire significant gains. However, most who complete their therapy sessions meet their individual goals. Standardized tests, unfortunately, are not given and therefore it is difficult to quantify improvements in comparison with measurable standards. Pre and post therapy measurements with standardized tests would provide

more convincing evidence for validating the enhancement of learning skills as a result of perceptual therapy.

With so many individuals benefiting from a program in perceptual therapy, it would be negligent to dismiss these results prior to investigating the compelling accounts evidenced in individual student successes. Therefore, further research is warranted in the efficacy of multisensory perceptual stress therapy. Theories and studies encompassing multisensory perceptual stress awareness supports performance enhancement training through multisensory perceptual stress therapy as a viable treatment option for improvement in reading and learning skills.

X. RESEARCH PROPOSAL

To help illustrate the impact multisensory perceptual stress has on improvement of learning skills and attention, a quantifiable inquiry using multisensory perceptual stress therapy will be conducted. Positive measurable gains multisensory perceptual stress has on children receiving therapy as compared to children receiving conventional methods of learning will be studied.

Hypothesis

When positive stress is administered to an individual as proposed by the multisensory perceptual stress model, it will result in expansion of learning capabilities, processing skills, and performance ability of various learning tasks.

Method

A prospective study of multisensory perceptual stress would consist of second grade learning disabled school children (as classified by state guidelines). Half of the

subjects would be randomly selected to be part of a multisensory perceptual stress program. The other half, matched by age, gender, and mental ability, would be placed in the control group. Both groups would meet once a week concentrating on the subject of reading. The multisensory perceptual stress therapy group would be drilled with timed reading passages to be read as quickly as possible while an auditory stimulus of single digit numbers are called out to them as they read. After the passages are read the subjects will then retell the events of the passages and sequentially name the numbers that were called out to them while they were reading the passages (this would simulate studies cited by Just and Carpenter, 1992). The multisensory perceptual stress applied would be in the form of vision (reading passages) and audition (recall of called out numbers) the stressor would be in reading acceleration (passages are timed for improved speed) and in memory recall of passage read and numbers called. During sessions each child is monitored to make sure the stress level is not overloaded above the child's Zone of Proximal Development. The control group would take part in a conventional reading remediation program.

Before and after the study is conducted, each subject would be given a Woodcock Reading Mastery test-Revised, Stanford-Binet Digit Span, Stanford-Binet Sentence memory, and Auditory discrimination Test (Joseph Wep, 1973), Wechsler Intelligence Scale for Children-Revised and Reading Span Task (Daneman and Carpenter, 1980)

Predicted Outcome

Similar to the results on Accelerated Reading Rate On Memory for Text (Breznitz and Share, 1992), I would predict gains in reading accuracy, comprehension and memory recall for those receiving multisensory perceptual stress therapy. The gains could be attributable to improved attention skills and heightened concentration demands with an increase in

demand of performance (stress), through accelerated reading and memory tasks.

The control group would also likely show improvement in reading skills from the one on one reading remediation program, but without the stress component (constant positive stress demands), the gains would not be as significant as with the treatment group. I would also predict subjective improvement within the multisensory perceptual stress therapy group in clarity of thought processing in "awareness" as well as a larger reading span capacity.

Other Suggestions For Future Research:

If this theory of multisensory perceptual stress is supported, then designing a study which would concentrate on sharpening reading skills in the reading environment could directly address the influence it has on reading. An example of this would involve the task of reading as quickly with comprehension as possible using base-in and base-out prisms on a flipper (tool that holds lenses for both eyes of a reader to see through while holding a handle that allows the reader to quickly flip two different sets of lenses in front of their eyes) while listening to Bach's "Toccata and Fugue." The importance of text comprehension is emphasized with the constant stress of increasing reading speed, keeping awareness of the melody of the song being played and perhaps flipping the prism orientation from base-in to base-out on every D minor!

Another study that could potentially show transferability of a multisensory stress model would be to research those already involved in a practice that simulates multisensory stress. Examples of such individuals would be tai-chi masters, and naturally gifted musicians. Tai-chi

masters have impeccable spatial awareness of their surroundings visually, auditorially, gustatorially and are able to maintain internal kinesthetic perfection in movement. In studying their reading and visual motor skills, findings may show some correlation between adaptability of environmental stress and reading comprehension skills. Similar results may be found among gifted musicians. During performance, they use ocular-motor skills in reading their music sheets, auditory and temporal perception in the music they produce, and are kinesthetic in their precise positioning of fingers, arms or feet. Pianists or violinists are some examples. These special individuals are able to balance the presence of constant stress in a manner that is positively motivating rather than negatively influential in acquiring their expertise. It would be interesting to have their reading span tested as well as test their adaptability of environmental stress upon their reading skills and comprehension.

BIBLIOGRAPHY

Berninger, V.W. (1994) *Reading and writing acquisition. A developmental neuropsychological perspective.* Dubuque, Iowa: Wm. C. Brown Communications, pp.8-17,57-59.

Breznitz, A., & Share, D.L.(1992) Effects of accelerated reading rate on memory for text. Journal of Education Psychology, Vol. 84, No. 2, 193-199.

Britton, B.K., & Graesser, A.C.(1996) *Models of understanding text.* Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc. pp. 76-77, pp. 106-109.

Cowen, N., Winkler, I., Teder, W., & Naatanen,R. (1993) Memory pre-requisites of mismatch negativity in the auditory event-related potential . Journal of Experimental Psychology Learning, Memory and Cognition, 19(4), 909-921.

Csikszentmihalyi, M., & Csikszentmihalyi, I. (1988). Introduction to Parts I-IV. In M. Csikszentmihalyi and I. Csikszentmihalyi (Eds.) Optimal experience: Psychological studies of flow in consciousness (pp. 3-265). Cambridge: Cambridge University Press.

Daneman, M., & Carpenter, P.A. (1980). Individual differences in working memory and reading. Journal of Verbal Learning and Verbal Behavior, 19, 450-466.

Forrest, E. B. (1988). *Stress and vision.* Optometric Extension Program Foundation, Inc., Santa Ana, CA.

Greenough, W.T. & Juraska, J.M.(1986). *Developmental neuropsychobiology.* Orlando, FL; Academic Press.

Griffin, S., & Case, R.(1990). Evaluating the breadth and depth of training effects when central conceptual

structures are taught. Monographs Of The Society For Research In Child Development, 61 83-102,205.

Grossberg, S., & Stone, G. (1986). Neural dynamics of word recognition and recall: attentional priming, learning, and resonance. Psychological Review. Vol. 93, No. 1, pp 46-74.

Jong, R.D. (1993) Multiple bottlenecks in overlapping task performance. Journal of Experimental Psychology, Vol. 19, No. 5, 965-980.

Just, M.A., & Carpenter, P.A. (1992). A capacity theory of Comprehension: individual differences in working memory. Psychological Review, 99 (2), 122-147.

Kramer, A.F., Strayer, D.L., & Buckley, J.(1990). Development and transfer of Automatic Processing. Journal of Experimental Psychology Vol.16, No.3, 505-522.

Lin, L.L., Shih, Y., Lee,Y., Hung, P., & Hou, P.(1995). Changes in ocular refraction and its components among medical students-a 5-year longitudinal study. Optometry and Vision 73(7),495-498.

Logan, G.D. (1990). Repetition priming and automaticity: common underlying mechanisms? Cognitive Psychology, 22, 1-35.

Lorch-Bacci, I., & Shankman, A.(1993). Vision enhancement. Journal of Behavioral Optometry, Vol. 4, no. 2, pp/ 38-42. 1993

Marcel, A.J. (1983) Conscious and unconscious perception: an approach to the relations between phenomenal experience and perceptual processes. Cognitive Psychology, 15(2), 238-300.

Marcel, A.J. (1986) Consciousness and processing: choosing and testing a null hypothesis. Brain and Behavioral Sciences, 9, 40-41.

McQuillan, J., & Conde, G.(1996) The conditions of flow in reading: two studies of optimal experience. Reading Psychology: An International Quarterly. 17:109-135.

Meredith, M.A., Wallace, M.T., & Stein, B.E.(1992) Visual, Auditory, and somatosensory convergence in output neurons of the cat superior colliculus: Multisensory properties of the tecto-reticulo-spinal projection. Experimental Brain Research. 88:181-186.

Miller, J.(1991). Channel interaction and the redundant-targets effect in bimodal divided attention. Journal of Experimental Psychology. 17(4),160-169.

Minsky, M. (1986). *The Society of Mind.* New York: Simon & Schuster.

Naatanene, R.(1990). The role of attention auditory information processing as revealed by event-related potentials and other brain measures of cognitive function. Behavioral and Brain Sciences, 13(2), 201-288.

Paivio, A. (1990) *Mental Representations* New York, New York: Oxford University Press.

Pashler, H. (1994). Dual-task interference in simple tasks: data and theory. Psychological Bulletin, 116(2),220-244.

Pepper, R.(1986). Developmental vision: a multisensory approach to stress therapy. Optometric Extension Program Foundation, Inc. Santa Ana, CA.

Pressley, M., & McCormick, C.B.(1995). *Cognition Teaching and Assessment.* HarperCollins College Publisher, New York, New York. 118-119, 179-192.

Selye, H. M.D.(1975). *Stress without Distress,* J.P. Lippencott Co., New York, New York.

Sigman, M.(1993). I Chuan, Dachengquan, and mind intent. Internal Strength, Watercourse Publishing, Vol. 1 pp. 13-14.

Skeffington, AM.(1950). Nearpoint optometry. Optometric Extension Program Curr II. 15:6:1.

Sternberg, R.J.(1996). *Cognitive Psychology.* Fort Worth, TX: Harcourt Brace and Company.

Valdes, M.R.(1988) A program of stress management in a college setting. Psychotherapy in Private Practice. Vol. 6(2).

Wallace, M.T., Meredith, M.A., & Stein, B.E.(1993). Converging influences from visual, auditory, and somatosensory cortices onto output neurons of the superior colliculus. Journal of Neurophysiology. 69(6)pp.1797-1807.

Wallace, R.A., King, J.L, & Sanders, G.P.(1986). Homeostasis: thermoregulation, osmoregulation, and excretion. Biology: The Science of Life (pp.824-826). Glenview, Illinois: Scott,Foresman and Company.