Article Eight - Audio-Visual Entrainment: A Novel Way of Boosting Grades and Socialization While Reducing Stress in the Typical University and College Student

Abstract: *Attention, concentration, memory, grade-point average and stress/worry are all primary concerns of the modern university and college student. Also, young adults are concerned about having a somewhat active social life in between exams, essays and deadlines. The stress of school shunts cerebral blood flow away from the cortex (during stress the brain assumes the body needs blood in the core to prepare for flight or battle which is just the opposite of what the present day student needs). This slows brain wave activity down into greater alpha and theta brain wave frequencies, similar to what is seen in those with ADD and ADHD, leaving the student more distractible, impulsive and hyperactive. This behavior in turn impairs the student's ability to study and write exams, thus increasing stress and using valuable social time needed to shake off stress and the potential of falling into depression. Audio-visual entrainment (AVE) has been shown to produce dramatic increases in cerebral blood flow, efficient brain activity and sound mental health. Several studies involving the use of AVE for enhancing academic performance have been completed. AVE has proven to be an effective and affordable aid to better grades and improved socialization.*

Introduction

All mental functioning involves an element of cortical (neuronal) arousal, that is, the alertness of the brain. The degree of the brain's arousal dramatically affects how well a particular function can be performed. For instance, it is almost impossible to pay attention if the brain is producing an excess of alpha or theta brain waves (Oken & Salinsky, 1992), just as it's difficult to fall asleep with a high beta to alpha ratio (alert mind) in an eyes closed condition.

About Our Schools

Practically all of our learning is visual and auditory based. Therefore, learning demands a great deal of mental processing from the visual and auditory circuits of the brain. College and university students receive a tremendous amount of information over short and often unrealistic periods of time. To further the stresses of learning, a problem of most universities is that the teaching style is largely *semantic*, the presentation of facts and figures without practical application. Being that semantic learning is not hands-on, nor tied to an event, it is the poorest form of learning. Remembering what was taught can be very difficult. So one's mind has to be sharp.

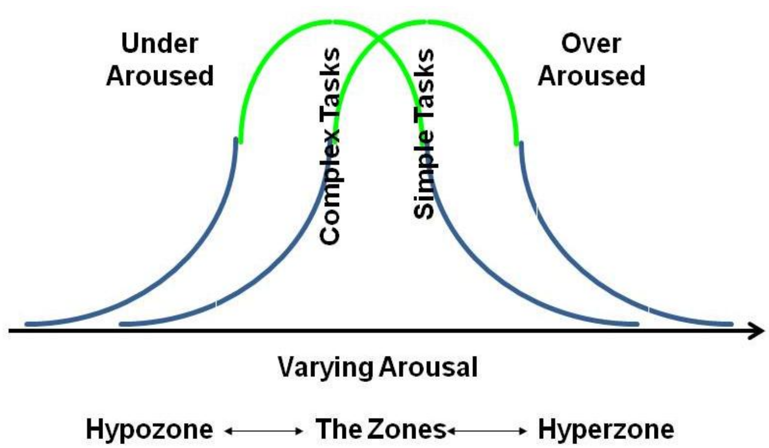
The heavy assignment loads, exam schedules and social stresses often cause psychological instability and anxiety when students try to cope with the pace of college learning. This shuts down mental functioning, which may lead to burnout and illness. Many university students experience an increase in the number of bacterial and viral infections throughout the school year, particularly at exam times. Many students also develop seasonal affective disorder (Berg &

Siever, 2009) or become deficient in vitamin D, a hormone essential to mental performance (Welland, 2009).

About the Zone

Socialized mammals, and particularly humans, have two performance zones (Figure 1). There is one zone requiring higher arousal for simple tasks and the other requiring lower arousal for complex tasks. So what would be a simple task? Running fast, climbing a tree, spearing some food, and punching an attacking animal or enemy in the nose are examples in which we show peak-performance under high arousal. This high arousal is generally accompanied by excitement and often anxiety. As the demands of a challenge increases, mental arousal must increase to meet those demands and this involves the production of norepinephrine (NE), the brain's adrenalin (Bremner, 2002). There is a point at which stress gets so high that there is an over-production of norepinephrine which causes increased anxiety and distraction (Aston-Jones, 1991). It is important to manage stressors, assignment timelines, and so on to avoid crisis situations that will spike NE production and ultimately impede performance. Caffeine has been shown to increase NE which is why students often do better under the influence of caffeine Robertson (1978). However, excessive caffeine intake eventually leads to impaired performance.

Figure 1. Arousal Curves for Different Types of Function.



Complex tasks, on the other hand, typically involve challenging the mind on a much grander level than simple tasks. Paradoxical as it may seem, complex tasks require that the body/mind be more calm than with simple tasks. Complex tasks involve calculating a math formula, learning new concepts, and driving a car in busy traffic, but the most important aspect of calm arousal is connecting as humans – meaning socialization.

Socialization

By living in tribes over the past two million years, our ancestors came to rely on socializing for all aspects of living. Socializing promotes group formation and it has been demonstrated that animals living in packs have increased chances for survival because of greater ability to fight off predators and increased success in hunting. Tribal living also provides an effortless supply of mates to procreate with, as offspring are essential for the continued existence of the tribe. Given that humans are quite particular about whom they mate with, socialization plays a vital role in mating. Socialization also spawned the development of both oral and written language, and as a result, information could be shared and good, high-level decisions could be made for the tribe. Socialization has also brought about a rich variety of expressiveness. We have roughly 4,000 facial expressions (Ekman, 2007, 2009), over a thousand body-language positions and movements (Navarro, 2008) and a vast repertoire of verbal expressions and intonations. This has further led to artistic skill-sets in drawing and sculpting.

Neurotransmitters

Serotonin and Behavior

Serotonin acts as the brain's brakes, keeping basic drives and emotions (such as sex, mood, appetite, sleep, arousal, pain, aggression, and suicide ideation) in check. Serotonin also boosts happiness and social dominance. Serotonin levels were shown to be high in salesmen with exceptional sales performance, averaging 180 ng/ml whole blood serotonin (WBS), whereas the poorer performers had average WBS levels of 140 ng/ml (Walton, et al., 1992). A study by Raleigh (Kotulak, 1997) found that when subordinate monkeys were given a serotonin reuptake inhibitor like Prozac, they became dominant through friendship and alliances with females, whereas dominant monkeys deficient in serotonin, ruled with aggression. Females have 20% to 30% more serotonin than men, which contributes to their reduced impulsiveness and aggression (Kotulak, 1997). College students with the most friends had serotonin levels 20% to 40% above the norm. People with higher than normal levels of serotonin connect better socially and have improved ability to perceive the thousands of facial expressions that really allow them to appreciate others (Harmer, et al., 2003).

Neurotransmitters, Alertness and Efficient Processing of Information

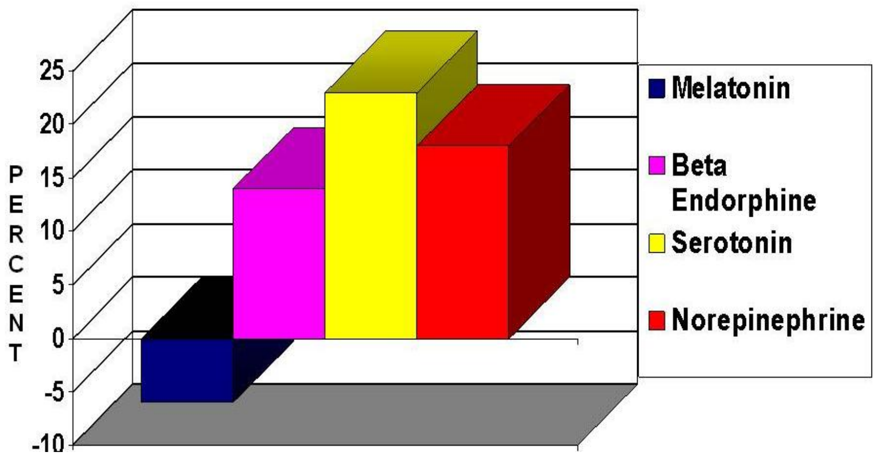
Once we have perceived an event (e.g., seeing something on the blackboard), the frontal lobes must engage to interpret the visual information that our senses have brought to it. The frontal lobes regulate attention, executive decision making and mood. Cerebral blood flow and the appropriate neurotransmitters such as serotonin (which maintains calmness) and norepinephrine (which maintains alertness) must be present frontally to process out sensory information.

Norepinephrine (NE) is the neurotransmitter that regulates alertness and mental sharpness. A good example of this comes from playing a video game. As the level of difficulty increases so must NE in order to stay in the game. NE increases on an as-needed basis along with cognitive demand. As stress increases, there is a point where the stress becomes a "threat" of sorts, causing a plunge in serotonin and a burst of NE, expressing itself as agitation and aggression. Students consume plenty of caffeine during the school year and particularly at exam time. This is because caffeine exerts its effects on the brain by increasing NE and therefore helping the student to meet the academic challenges as they increase.

Given that the school year typically runs through the winter, Seasonal Affective Disorder (SAD) can impair performance, as melatonin, the neurotransmitter responsible for producing SAD (Rosenthal, 1993), increases drowsiness and foggy-headedness. Many students who experience this will consume more caffeine or get more stressed (and thus produce more NE) from getting behind in their school work.

A study by Shealy et al (1989) found that blood serum levels of serotonin, endorphin, and norepinephrine all rose considerably following 30 minutes of 10 Hz, white-light AVE (Figure 2). This correlates to being relaxed, but mentally sharp. Increases in endorphins lead to an increased sense of well-being and increased tolerance to pain (which can be helpful when experiencing a stiff neck, shoulders and back from sitting and studying for extended periods of time). AVE reduces daytime levels of melatonin, which increases alertness.

Figure 2. Changes in Various Neurotransmitters following a 10 Hz AVE Session.



About Stress, Memory, and Performance

Stress has profound effects on academic performance. Stress affects both the way we retrieve memories and cognitive flexibility. The parts of the body that are most likely to succumb to the wear and tear effects of stress over time are those areas which are mobilized during the stress response, including memory (Bremner, 2002).

It has been long known that there are impairments in memory during a moment of stress. In 2006, a research team led by Marian Joels at the University of Amsterdam, (Schmidt & Schwabe, 2011) ran a series of studies which showed that during a stressful event, cortisol (our primary stress hormone) alters the memory circuits so that the details of the *event* are well remembered, and roughly an hour afterwards, the memories of that event are consolidated to make sense of what just occurred. This is an important survival strategy, as having well-established memories of a stressful event (an event considered dangerous by the brain) was essential for survival throughout human evolution. Our ancestors would, by and large, have only experienced stress during serious threats to their lives, and didn't encounter the stress of writing exams back then.

In a school setting, the memories that were formed during the long hours of study are all but forgotten during an exam if the individual is stressed (our evolutionary brain would not have evolved for this). Unfortunately, the student often will remember all of the details surrounding the exam, such as the room, the facilitator, other students, sounds, and exam questions, but not the information that was relevant for the test itself until the day after the exam is over.

Semantic memories involve basic facts and figures (which are prevalent in a college setting). There are two types of semantic memories; generic and specific. Generic memories involve shared properties of whole classes of things. Generic memories are used often, involve several brain regions, and are retained well under stress (Goldberg, 2005). For instance, we would know the difference between sandals and runners, even under stress. But we might not know that the island of Giglio is part of Italy, because we don't have a contextual attachment to that island, unless we have a fascination with cruise-ships, or had a close relationship with someone who almost died on the Costa-Concordia when it sank this past winter (now rendering a contextual relationship). Under stress, I might easily remember that operating a toaster and coffee-maker simultaneously will flip the breaker, but I would have a much tougher time remembering exceeding an electron flow of 9.36×10^{19} electrons / second will flip the breaker. So under stress, general contextual semantic memories and skill-based memories, such as using a tool or riding a bike are barely affected. "Doing" type of actions were much more essential to survival with our ancestors. Therefore, the brain has learned to preserve these memories under stress. The best way to recall specific facts and figures is to be relaxed while writing exams.

Another study at the University of Trier in Germany (Schmidt & Schwabe, 2011), demonstrated that students lost mental flexibility and succumbed to simpleminded learning instead of a more mentally-taxing spatial learning strategy following exposure to a social stress test. As a result, the students who were not stressed outperformed the stressed students in solving a spatial challenge.

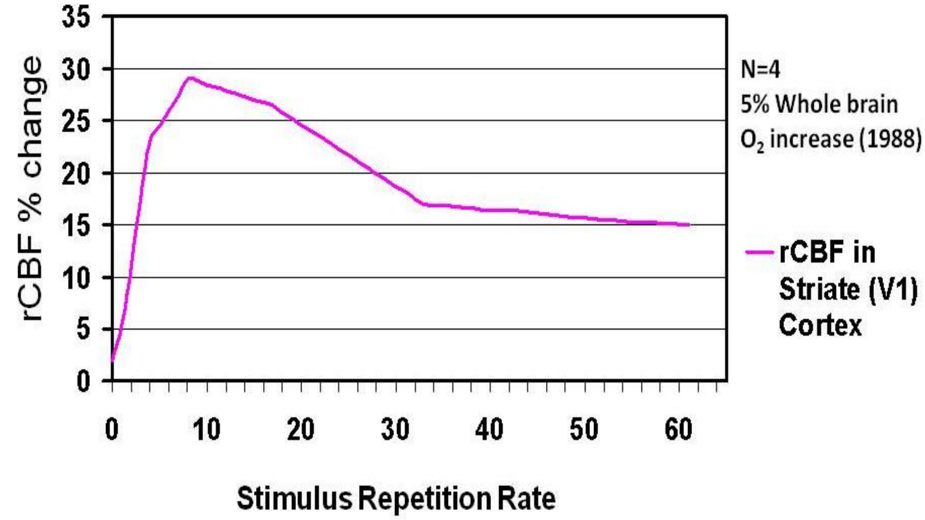
The Brain Blood-Flow Connection

During cognitive tasks, the brain's demand for cerebral blood flow (CBF) is increased. Vinpocetine, an extract from the periwinkle plant has been shown to increase CBF (Gold, et. al., 2003). In studies of seniors with memory problems or dementia-related disease, the use of vinpocetine produced improvements in attention, concentration and memory.

Everything we see is routed into the occipital lobe where the visual cortex resides. This is our first line of visual processing. When the task of seeing is handled well, we can make sense of what we see faster and better and we can therefore grasp new concepts and jot down notes the faster and better. Good visual processing for reading, interpreting charts, graphs and mathematical expressions is fundamental for good academic achievement.

Photic stimulation also boosts cerebral blood flow (Fox & Raichle, 1985; Sappy-Marinier et al., 1992). Fox and Raichle showed that flashing a wide variety of frequencies through the eyes increased CBF substantially at all frequencies above 4 Hz in the occipital cortex as shown in Figure 3. The entire brain also showed increased metabolism by 5%.

Figure 3. Effect of Photic Stimulation on Cerebral Blood Flow.

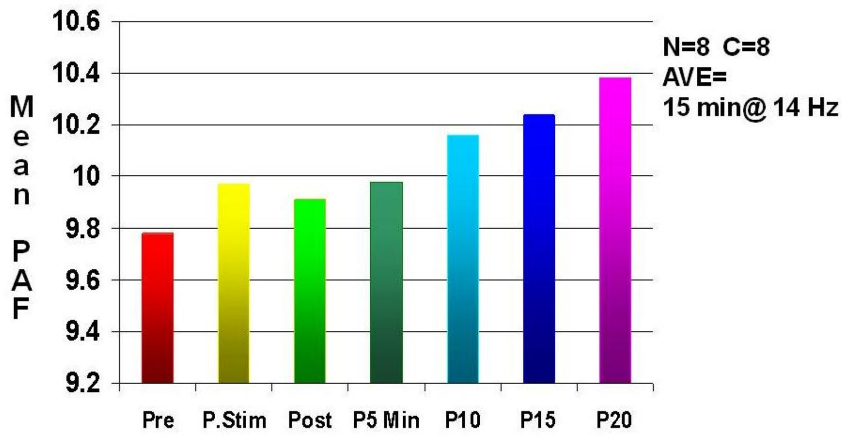


Academic Performance and the Alpha Brain Wave Rhythm

Several studies have been completed showing the relationship between peak alpha frequency (PAF) and intelligence. In 1996, Anoukhin and Vogel observed 101 healthy males ranging from 20 to 45 years of age. They discovered that those who scored well on the Raven's IQ tests had a scant 1 Hz faster alpha rhythm than did the poor performers. In 1971, Eeg Olofsson reported that healthy human alpha production was in the range of 9.3 to 11.1 Hz. A 1990 study by Markand showed that a dominant alpha frequency of 8.5 Hz or lower reflected a state of mental dysfunction. Other studies by various research teams; Vogt, Klimesh and Doppelmayr (1997), Jausovec (1996), and Giannitrapini (1969) showed a distinct relationship between mental performance and peak alpha frequency. Peak alpha frequency at less than 9.5 Hz is associated with poorer than average academic performance, while dominant alpha production at higher than 10 Hz is associated with better than average academic performance. Several professors of neurophysiology have found that their brightest graduate students have a peak-alpha frequency (PAF) in the range of 10.5 - 10.7 Hz. Those with a PAF above 11 Hz are mentally sharp, but have a tendency to struggle with anxiety.

Back in 1998, Budzynski and Tang conducted a peak alpha experiment with AVE. Fifteen minutes of photic stimulation at 14 Hz was given to 14 people. (Budzynski, et al, 1999). Peak alpha frequency increased following the cessation of photic stimulation (Figure 4). The pre-stimulation dominant alpha average frequency was 9.8 Hz, which increased continuously to 10.4 Hz., 20 minutes post stimulation, and continued moving upwards thereafter.

Figure 4. Peak Alpha Frequency following AVE.



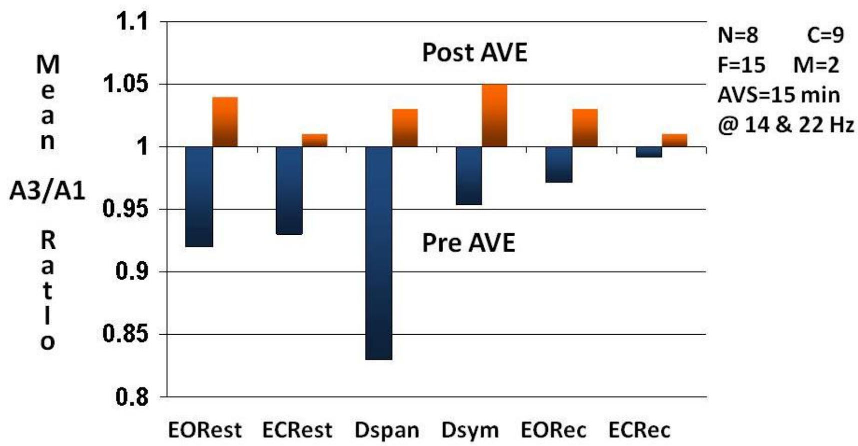
Studies of Audio-Visual Entrainment In Relation to University, College and High School Students.

Budzynski Study: Using AVE to Improve Cognition and Academic Performance in College Students

Tom Budzynski and colleagues (1999) divided the typical alpha band into three separate bands: A1 represented 7 to 9 Hz; A2 represented 9 to 11 Hz; and A3 represented 11 to 13 Hz. They examined the A3/A1 ratio. If, for example, there was 15 µv of A3 activity and 12 µv of A1 activity, the ratio would be 15/12 = 1.25. Based on previous findings, a ratio exceeding 1 was considered to equate with better than average mental performance and a high PAF, while a score below 1 equated with poorer than average mental performance.

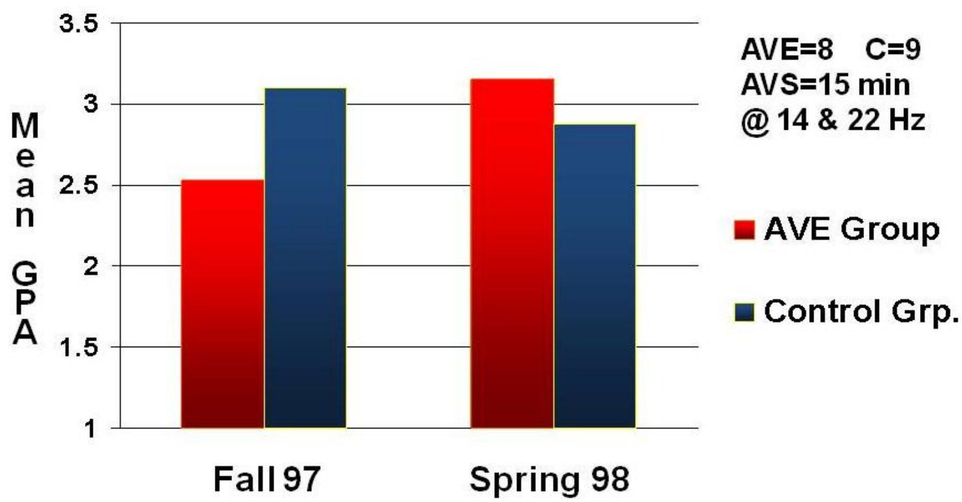
A group of students from Western Washington University (n=8), who were struggling academically and receiving tutoring, were chosen for the study. EEGs were collected and the A3/A1 ratios were calculated while the students were completing a variety of mental tasks. As shown in figure 5, average alpha slowing (as indicated by the negative ratio) was apparent across all measures and in particular the Digit Span task. This is an indication of impaired attention and memory. The Digit Span task requires remembering progressively longer strings of numbers until they can no longer be remembered. Following 30 sessions of repeating cycles of 14 and 22 Hz AVE, mean alpha frequency (positive ratio) increased. The positive alpha ratio continued across all tasks (Eyes-open at Rest, Eyes-closed at Rest, Digit Symbols, Eyes-open Recall, Eyes-closed Recall) indicating heightened mental performance (a reversal of the control group) and improved performance.

Figure 5. AVE at 14 Hz Corrects Slow Brain Wave Activity during Tasks.



The 30 AVE sessions were completed in the fall of 1997 and the students' marks from their spring exams were recorded and compared against a control group (figure 6). Notice the AVE group showed improvement in grade-point average (GPA) over the course of the year while the controls showed a decrease in GPA. This study demonstrates that the carry-over effect following the cessation of AVE treatment continued for at least four months.

Figure 6. Improved GPA as Compared with Controls following 30 Sessions of AVE.



Wuchrer Study: Memory and Concentration - 2009

This study, by Viktor Wuchrer (2009), examined the memory and concentration ability of 78 students from the Psychological Institute of the Friedrich-Alexander University Erlangen-Nürnberg. The selected students were randomly assigned to one of three groups: an Alpha AVE group; a Beta/SMR AVE Group; and a Control Group. The students in the Beta/SMR AVE Group were given one AVE session using the Mind Alive Inc., patented dual-frequency eyesets, which stimulate a beta frequency into the left hemisphere of the brain and an SMR frequency into the right hemisphere of the brain. This combination has been shown to boost attention (Siever, 1998; 2004; 2007). The Alpha AVE Group received one AVE session at a randomized alpha frequency of roughly 10 Hz.

Pre-tests.

At the beginning of the experiment each participant was subjected to a Pre-Test in order to measure his/her memory and concentration-performance. To measure memory performance, the sub-test objects from the Baeumler Memory Test (1974) had been administered to each participant. Also, each participant had to undergo the Brickenkamp d2 Concentration Test (2002) in order to evaluate his concentration-performance.

Treatment.

Following the Pre-Test, each participant was randomly assigned to the respective Treatment:

The participants in the Alpha group received 20 minutes of AVE with a stimulation frequency of 10 Hz ("Healthy Alpha" session) from a DAVID™ AVE device.

The participants in the Beta/SMR group received 20 minutes AVE with dual frequency stimulation to the brain (Brain Brightener Protocol). The left brain-hemisphere was stimulated with a pulse rate of 18 to 20 Hz and the right brain-hemisphere was stimulated with a pulse rate of 13 to 14 Hz.

The participants in the control group received no stimulation. Instead they read a relaxing prose text for a fantasy journey and wrote a short essay afterwards, which represented the placebo treatment.

The experimental hypothesis was that the higher stimulation frequency within the Beta range for the left brain hemisphere would cause a corresponding activation of logical-analytic thinking. The Brain Brightener protocol in theory should accordingly produce better concentration-performance for the Beta/SMR group of students as compared with the Alpha Group. Similarly, the investigators hypothesized that the Alpha Group would produce the best improvements in memory. The participants of the control group received no stimulation. Instead, they read a relaxing prose text for a fantasy journey and write a short essay afterwards, which represented the placebo treatment.

Figures 7 and 8, show the results comparing each experimental group to the placebo control group. The charts clearly indicate that the DAVID AVE device produced exceptional results for both concentration and memory. Surprisingly, the controls actually performed worse on the post trial, whereas the AVE groups excelled. The poor performance of the controls might be attributed to mental fatigue from the testing, whereas the AVE group had sustained endurance.

As hypothesized, the Beta/SMR brain wave frequencies produced better results for concentration and the alpha frequency produced better results for memory. There were immediate improvements in academic ability following the use of the DAVID AVE for both experimental groups.

Figure 7. Improvement in Concentration following AVE.

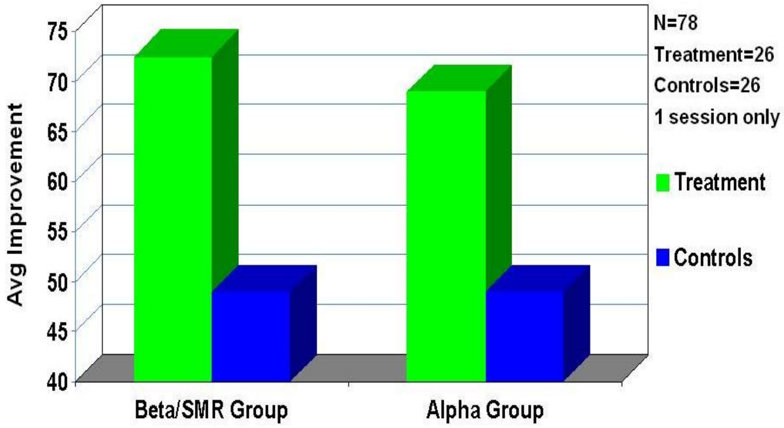
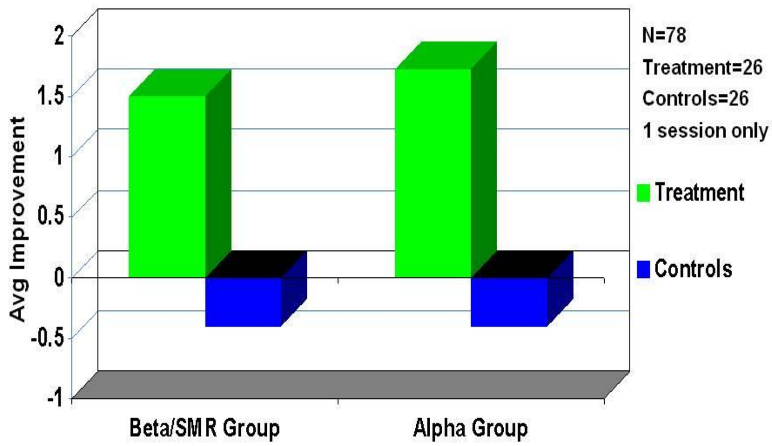


Figure 8. Improvement in Memory following AVE.

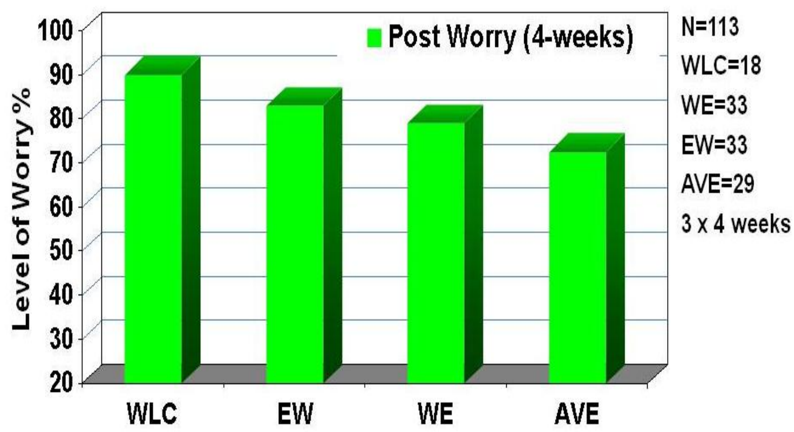


Wolitzky-Taylor Study - Worry and Academic Performance

Stress causes a shunting of cerebral blood flow away from the brain and into the body as the brain prepares for fight or flight (Everly & Lating, 2002). This, in turn, increases impulsiveness, impairs flexible thinking and hampers the retrieval of memories during critical times, such as exams. So being able to avoid worry is essential for good academic grades as well as overall health, a happy disposition and increased socialization.

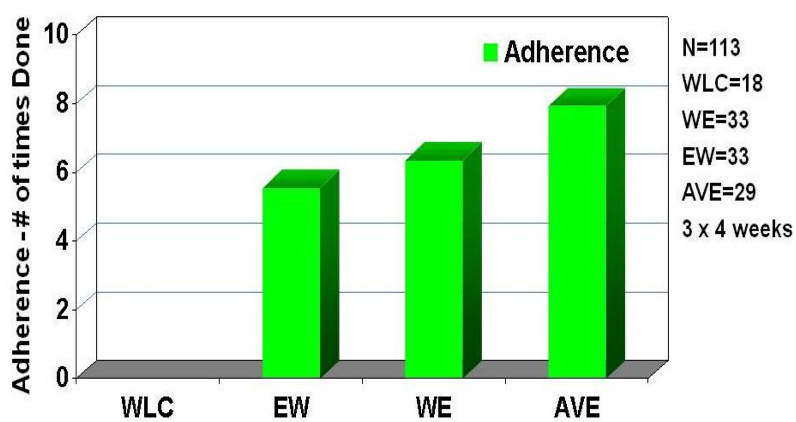
A Texas-based study by Wolitzky, et al., (2010) found that AVE from the DAVID AVE devices was more effective in reducing worry than traditional psychological worry-reduction techniques. Wolitzky used the patented Mind Alive Inc., dual-frequency eyesets, which stimulated a beta frequency into the left hemisphere of the brain and an alpha frequency in to the right hemisphere of the brain. This has been reported to reduce anxiety and depression (Siever, 1998; 2004; 2007). The study was four weeks in duration and the students received their respective therapy three times per week. Figure 9 shows that compared to a Waiting List Control group, a Worry Exposure Therapy group and an Expressive Writing group, AVE was the most effective technique for reducing worry.

Figure 9. Worry Reductions following Various Treatments



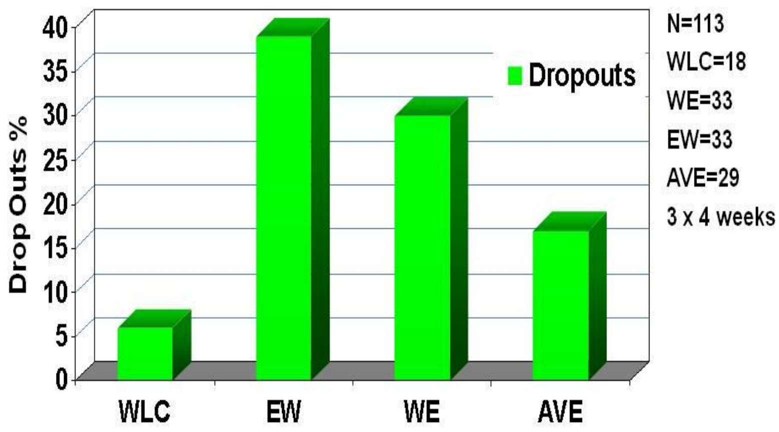
Sticking to a particular therapy is always of concern to health professionals, because if their patients don't keep to the therapy, the patient may not improve and the clinician may lose faith in the treatment due to increased failures. The benefit of DAVID™ AVE, is that unlike Worry Exposure and Expressive Writing, which require a moderate amount of effort, the DAVID AVE provides an *effortless* treatment for improving academic ability and therefore adherence and compliance are easy to maintain, as shown in Figure 10.

Figure 10. Compliance during Various Treatments



If the treatment is easy to implement and adherence is high, then it is likely that the client will stay vigilant with the therapy. Figure 11 shows that most students using AVE kept to it and completed the study, most likely due to the ease of use of the DAVID™ AVE devices.

Figure 11. Dropouts during Various Treatments



Conclusion

These studies show that audio-visual entrainment using the DAVID™ AVE device and patented Omniscreen eyesets provides a useful tool for boosting concentration, memory and grade-point average, while simultaneously reducing worry. AVE is easy to use, inexpensive, and doesn't require a prescription. The benefits in concentration, memory, and improved well-being are measureable and educationally significant and may be appreciated almost immediately. The implementation of the DAVID™ AVE device in an educational setting will allow students to achieve better grades with less stress, while having more time for socializing and enjoying family, friends and life.

About the Author

Dave Siever, CEO of Mind Alive Inc., has been studying the mind and designing Audio-visual Entrainment (AVE), Transcutaneous Electro-neural Stimulators (TENS) and cranio-electro stimulation (CES) devices since 1981 when he originally developed the Neuropulse II (TENS device) to relax the jaws of TMJ patients and the DAVID1 (AVE device) to help performing-arts students overcome stage fright. Dave later began developing transcranial DC devices in 2007. Dave has lectured and provided workshops with leading psychological institutions including the Association of Applied Psychophysiology and Biofeedback, the International Society of Neurofeedback and Research, the College of Syntonic Optometry, American College for the Advancement of Medicine, Walden University, the University of Alberta, Open University-England, A Chance to Grow Charter School, the International Light Assn., STENS Biofeedback Training Programs and other venues.

For more information, please contact:

Mind Alive Inc. Edmonton, Alberta Canada	Website: www.mindalive.com Email: info@mindalive.com Phone: 780-465-6463 (MIND)

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