The following is a chapter from the book entitled: *"The Rediscovery of Audio-Visual Entrainment"* by Dave Siever, C.E.T. copyright 1997

INTRODUCTION

In order to have a beneficial light and sound (L&S) / audio-visual entrainment (AVE) experience, brainwave entrainment (BWE) must first be achieved. Although the L&S experience is personal and subjective, ensuring that the auditory and visual stimulation reaches the brain without any distractions to the conscious mind is very important. BWE is the brain's resonant rhythm as it responds to auditory and visual stimuli. Even tiny inconsistencies in the stimuli can and do upset the process of BWE and its associated psychological states of mind such as a meditative trance or lucid dream. Therefore, there are specific rules or criteria that should be met to ensure the effectiveness of the AVE device. These rules of BWE are based on the laws of physics and our own psychological tolerances. For instance, rules of physics and science apply to seemingly simple actions, such as a light striking the eye and creating an impulse along the optic nerve. Rules of mind are generally in the form of guidelines since they involve our belief systems, physiological and anatomical makeup and our perception of our environment. For example: How do unusual sounds or abrupt shifts in stimuli affect what a person thinks? How does this affect his/her ability to enter a trance state?

Failing to achieve AVE may put an L&S device into the category of an entertainment device, not a brainwave entrainment device. The value of the device is now reduced to that of a toy, not a tool.

BWE can be produced by gazing into the flickering, warm flames of a fire or from the flickering of the white lines as you drive down a highway in the black of night. However, these are not effective methods of producing BWE. With the invention of BWE devices, all of the criteria for producing BWE can be meticulously controlled. For instance, the frequency, volume and intensity of the pulsing lights and tones, the steadiness of frequency, the pulse width, the visual field size and color of the light stimuli may be easily altered and controlled. But do

manufacturers of these BWE devices attempt to control these aspects of stimulation in order to obtain the best possible effects of BWE? Many do not. This chapter is intended to explain the critical technical and psychological factors that are necessary to produce BWE. This will, hopefully, allow you to make an informed decision about which BWE device to purchase or to help you understand why a particular device does not produce BWE or why a particular person may not respond to BWE.

The rules which must be followed to produce reliable and safe BWE are:

1. Frequency Rule
2. Power Rules
3. Consistency Rules
4. Psychological Compatibility Rules

FREQUENCY RULE

Most objects will vibrate at a particular frequency based on its mass, size, elasticity and tension when struck by some other object. Musical instruments illustrate these vibratory qualities because of their excellent resonant characteristics. Because of resonance, a musical instrument will begin to vibrate when in the presence of a sound with a frequency the same as its resonant frequency. To illustrate this, place a tuned guitar near a piano. Strike the "E" key on the piano. Shortly thereafter, the "E" string on the guitar will also begin to make a sound of the note "E". Play an "F", "G" or other note on the piano and the "E" string on the guitar will not make a sound, although other guitar strings will sound when their corresponding note has been struck on the piano. This transfer of energy from the piano to the guitar (in this example) occurs because the guitar string resonates at the same resonant frequency. Radio and T.V. are also examples of resonance in action. We can hear the radio or T.V. station when we select the resonant frequency in the radio that matches the frequency of the radio or T.V. station. An adult human ear has a resonant frequency band from 20 Hz to about 16 kHz. Neither a dog whistle nor the sonar from a bat can be heard by humans because these sounds which are in the resonant range of hearing for dogs and bats are beyond the resonant range of human ears.

The human brain has its own resonant frequencies. Normally, when we close our eyes, the visual cortex at the back of the brain (occipital region) produces an alpha rhythm. The amount of alpha activity varies from person to person. In 1940, Toman discovered that the more natural alpha produced in the visual cortex by a person resting quietly with closed eyes, the narrower the photic resonance range. A person producing little alpha with his/her eyes closed, had an increased photic resonance range. All persons in the study had strong resonance at their own natural alpha frequency which was between 9 and 11 Hz. (The BWE frequency range varied from person to person.) Toman's study showed why some persons do not have BWE at certain frequencies. For instance, a person may enter a deep trance at 8 Hz, but not entrain at all at 5 Hz. Figure 1 shows this relationship between closed-eyes alpha and photic BWE.

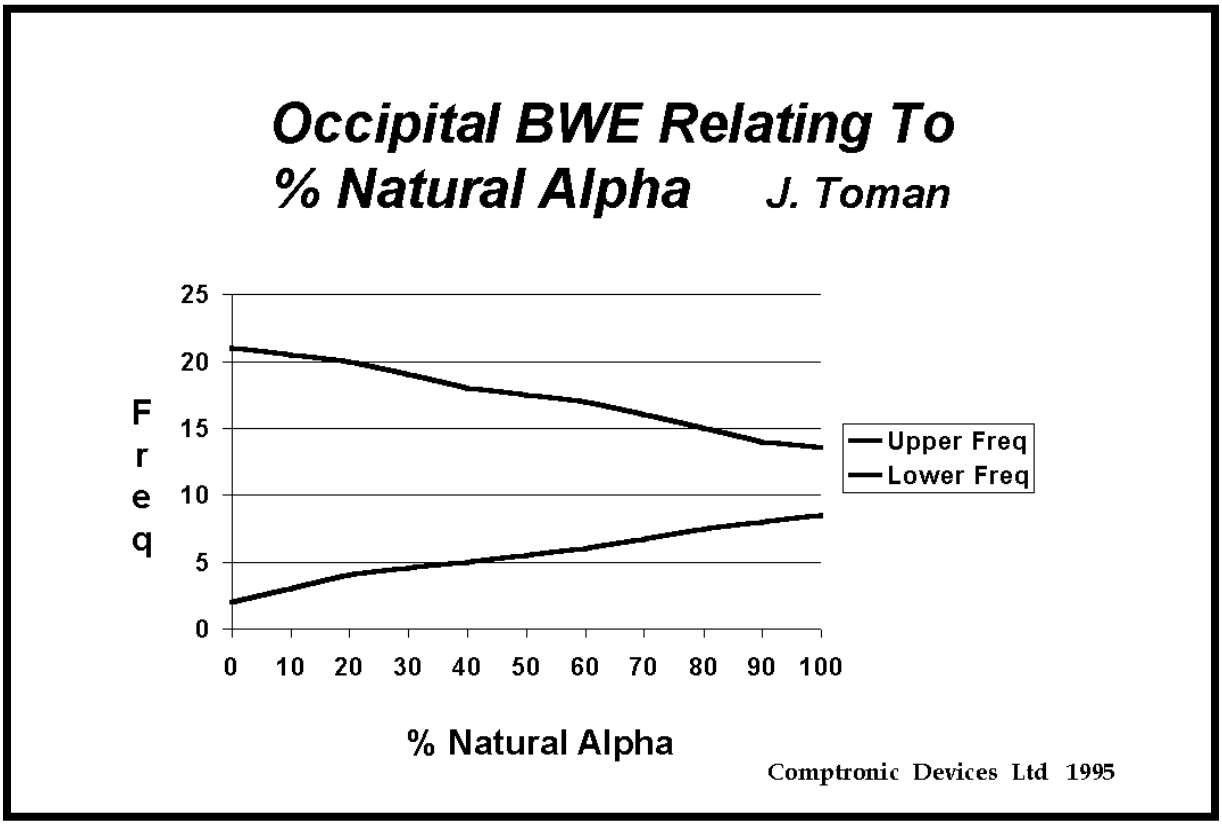


Figure 1

POWER RULES

There are four factors necessary to get the best possible transfer of power from one source to another (for example, getting the power from a flickering light or tone to cause a related action to occur within the brain). They are:

A) Power Factor
B) Power Transfer
C) Visual Size Factor
D) Visual Spectrum Bandwidth Factor

A) Power Factor

Once we are stimulating within the frequency range, we need to have sufficient power to produce BWE. Like listening to the radio while driving away from town, the signal strength from the radio station becomes weaker and weaker until the signal becomes so weak that it can no longer evoke resonance within the radio's circuits and the station can no longer be heard.

Similarly, if the light intensity or sound volume is very low, BWE may not occur. Van der Tweel found that a level of 200 lux was necessary to produce BWE when using sinusoidal, white light and stimulating the entire visual field. Our findings using the Omniscreen™ eyesets used in the Paradise systems revealed similar results. With auditory stimulation, the volume and stimulation type are also important in producing BWE.

B) Power Transfer

Assuming that we are stimulating at the resonant frequency, we now need to transfer the most energy into the brain with the least effort. For example, when swinging a pendulum, we must push on the pendulum for the optimal period of time in order to get the most swing with the least amount of energy put into it. For instance, if we touch the pendulum very briefly, it won't swing far. On the other hand, if we push the pendulum well past the centre of its swing, we will be using a lot of energy which will only interfere with its swing.

With photic driving, a similar effect occurs. In the late 1930's, Toman observed that pulses of light, which flashed very briefly, did not excite neurons and generate much BWE. Also, flashes of light that were on most of the time did not give

neurons in the visual cortex time to repolarise or swing back to their resting state and effectively respond to the next stimulus, and therefore did not produce much BWE either. However, stimuli with pulse widths of 20% to 60% provided the highest amount of photic driving. Figure 2 shows the results of Toman's findings.

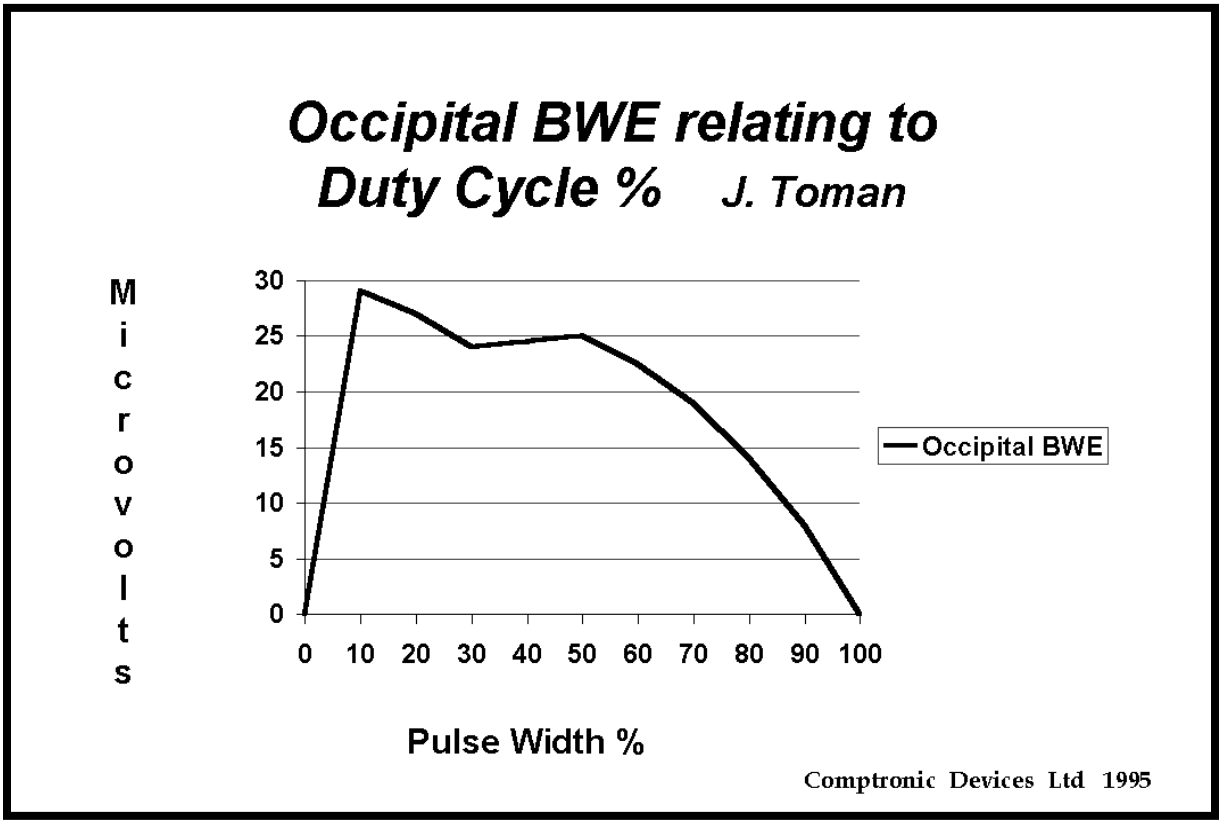


Figure 2

C) Visual Size Factor

The number of receptors in the eye that are stimulated by a pulsing light depends upon the size of the visual field that is stimulated. The larger the visual field stimulated, the more receptors that will respond and send the associated signal to the brain. Also, a psychological effect occurs. When a person's eyes move around (left, right, up, or down), the illuminated "area" within the visual field also moves around. If the area covers the entire visual field, then the person will not notice any difference in illumination during normal eye movements. If the illuminated area is small, then a "spot" will be illuminated. This spot doesn't stimulate many

eye receptors and therefore passes a small signal to the brain. Also, the spot will "jump" around when the eyes move. The brain perceives this movement of the spot as "information". The brain is consequently distracted by it, which interferes with the BWE process.

An eyeset containing four light emitting diodes (LEDs) per eye will typically illuminate an area of 0.5 square inches (3.2 square cm) per eye (small field of view), whereas an Omniscreen™ eyeset (using a reflective incandescent system) illuminates two square inches (13 square cm) per eye (large field of view). Figure 3 shows the relative difference in visual size between an LED eyeset and a full field eyeset such as the Omniscreen™ reflective incandescent system.

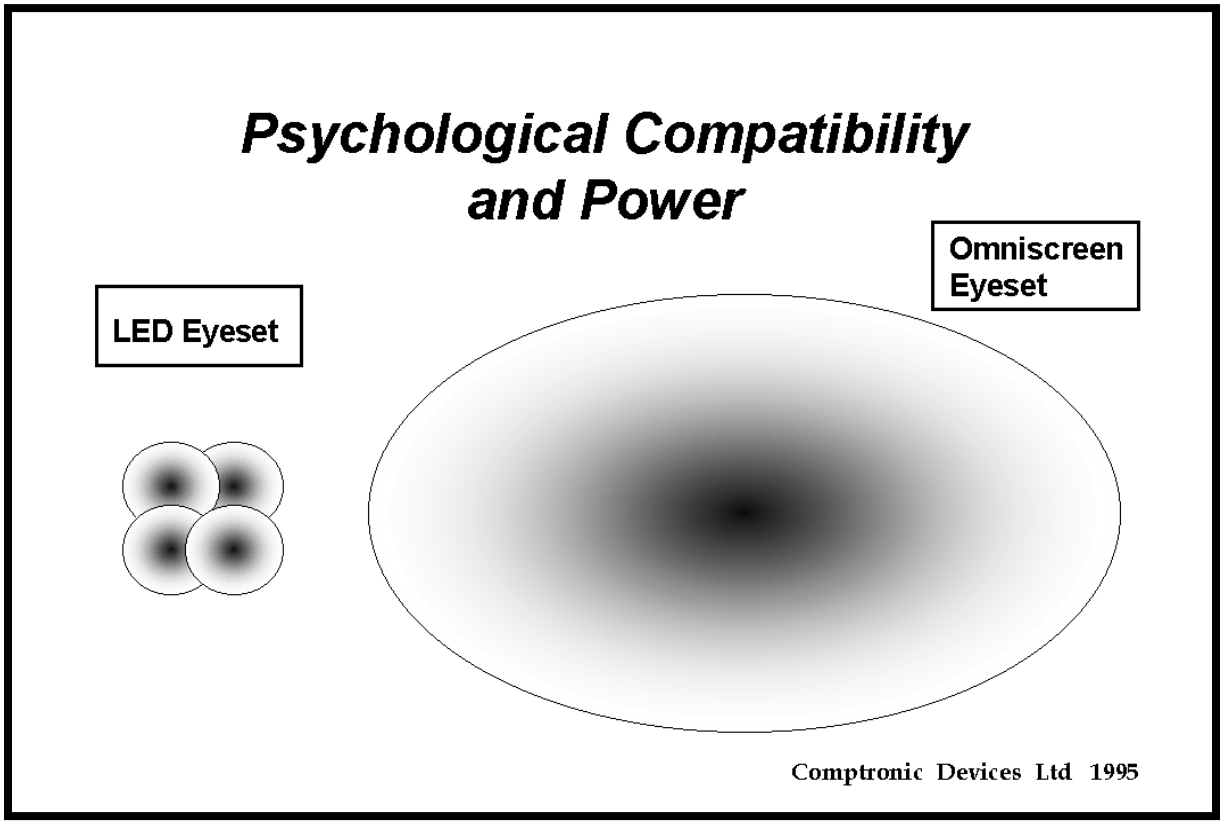


Figure 3

D) Visual Spectrum Bandwidth Factor

The spectrum of colors also affects the eye, both physiologically (the actual signals traveling to the brain) and psychologically. Red and green LEDs produce monochromatic light (one color) which stimulates only one cone in the eye while yellow LEDs stimulate more cones than red or green LEDs. White light produces all of the colors of the visible spectrum and therefore stimulates the red, blue and green cones of the eye. The Omniscreen™ eyesets are filtered to balance the red/ blue light ratio. Figure 4 shows the portion of the visual spectrum illuminated by white lights and red LEDs.

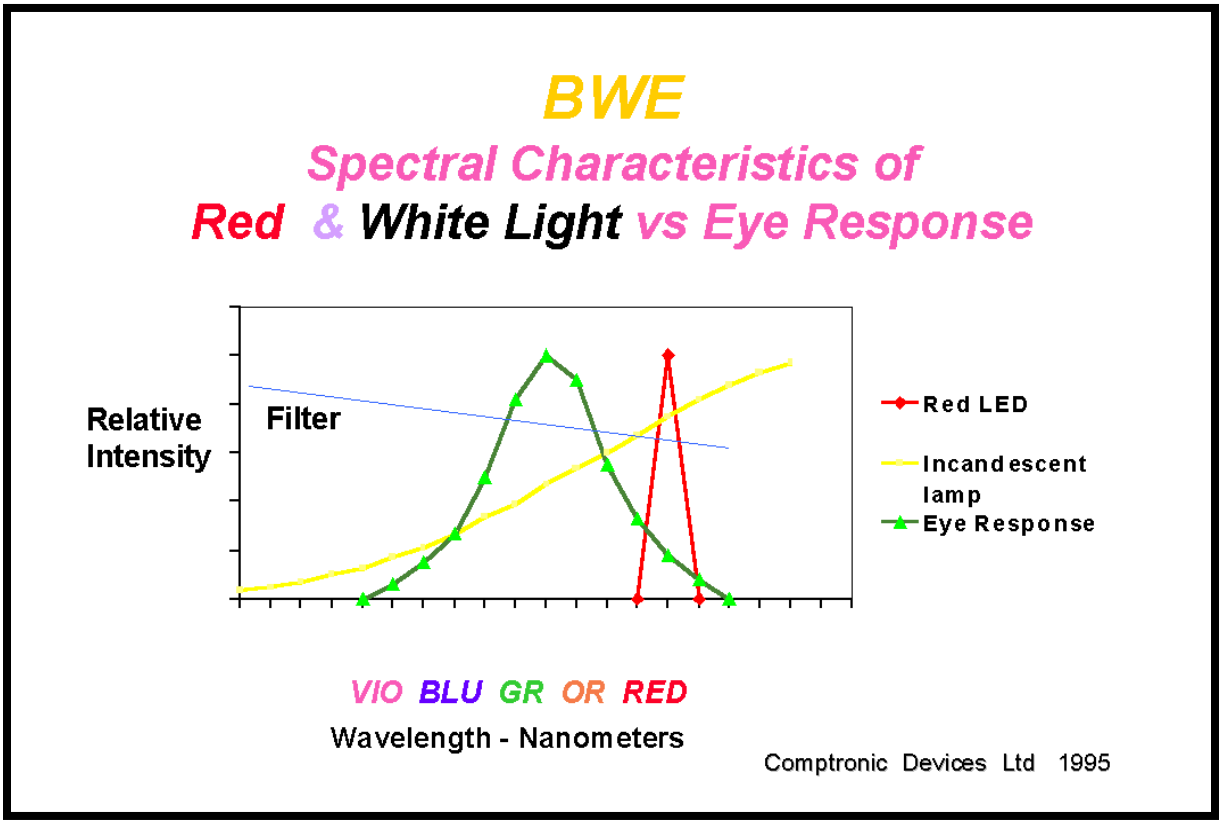


Figure 4

CONSISTENCY RULES

With today's modern electronics, exact and stable frequencies are very easy to produce. Yet some light and sound devices produce frequencies which are erratic and not consistent with claims in their operator's manual. This section explains why consistency of the stimulus frequency is so important.

The consistency rule is made of two sub-parts:

A) Consistency of Frequency Rule
B) Consistency of Power Rule

A) Consistency of Frequency Rule

Like the resonance example mentioned earlier, consistency is also important. If the frequency is constantly changing up and down, very little power will transfer and only a small amount of resonance will occur. Like constantly changing the tuner on a radio, the many stations coming in at the same time would be completely garbled, and the few segments of sound coming in from a particular radio station would make no sense at all.

Consistency problems can occur with BWE devices if there are software or hardware problems, or if the designer has intentionally or inadvertently made the device an entertainment and not an entrainment device. Typically, it takes six minutes for BWE to occur while in the alpha band (the most effective frequency band). Figure 5 shows an example of an entrainment session and Figure 6, that of an "entertainment" session.

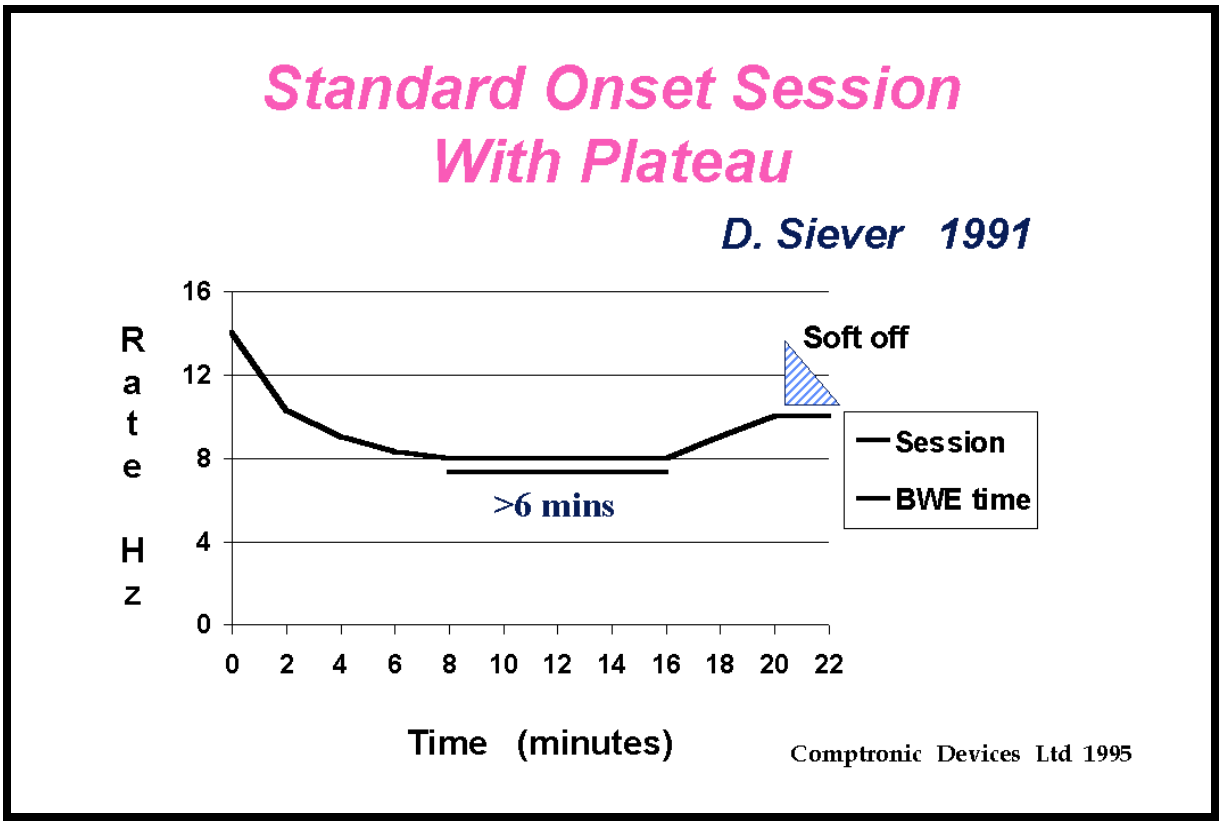

Standard Onset Session
With Plateau
D. Siever 1991
Rate Hz
16
12
8
4
0
0 2 4 6 8 10 12 14 16 18 20 22
Time (minutes)
Soft off
>6 mins
Session
BWE time
Comptronic Devices Ltd 1995

Figure 5

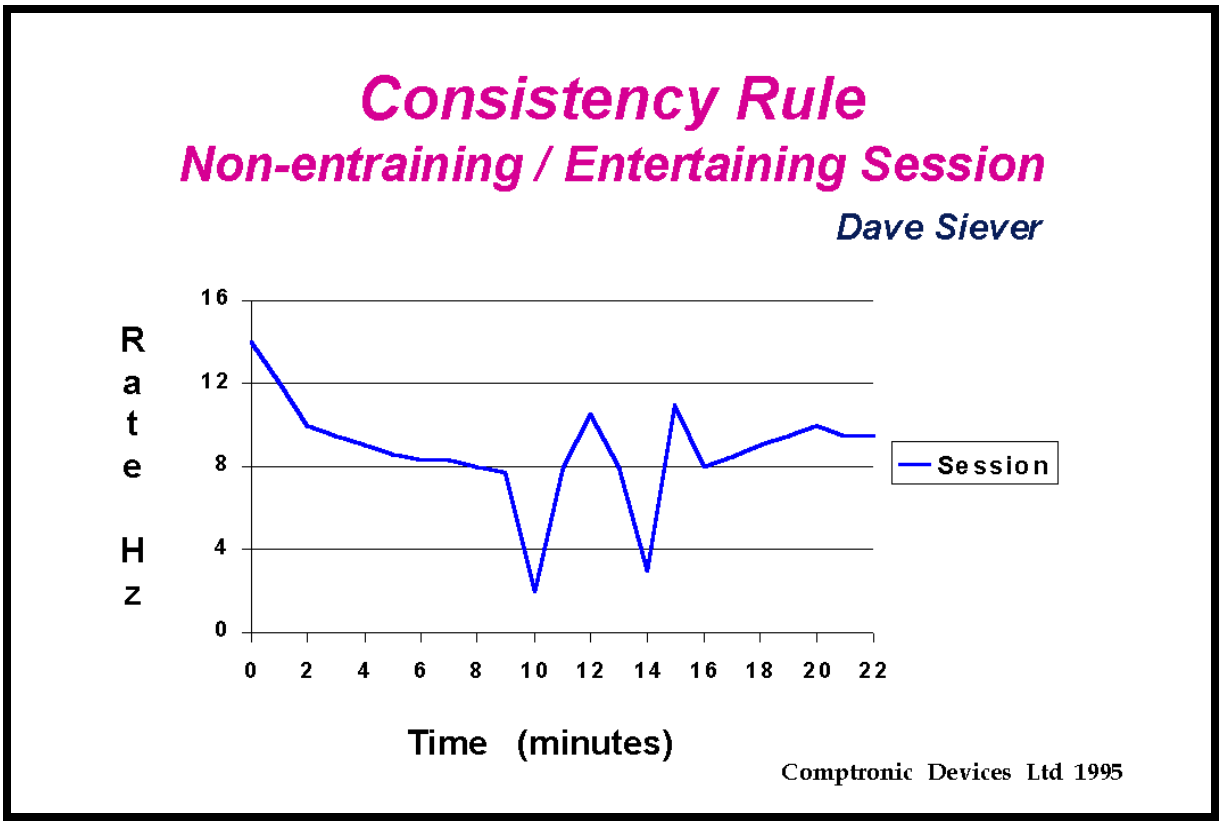


Figure 6

B) Consistency of Power Rule

When there are changes in the frequency or rate of the stimuli, the actual pulses of audio and visual stimuli may be presented in two ways.

1) Fixed pulse width or fixed pulse duration method
2) Fixed duty cycle or fixed percentage method

To explain the consistency of power rule requires a good understanding of pulse width, duty cycle (DC), and the cycle time of a given frequency or rate. The cycle time of a given frequency is simply the reciprocal of the frequency or rate. For example, a stimulus frequency of 10 Hz would be repeating itself every 0.1 seconds or 100 milliseconds (1 second divided by 10). The DC is the time that a stimulus is "on" divided by the total time "on" plus the time "off", which is the total time of the stimulus interval. This is also called the pulse rate.

The "fixed pulse width" or "fixed pulse duration" method is when the length of time the stimulus is "on" is constant, regardless of the frequency of the stimulus. This will change the duty cycle as the frequency or rate is changed. For example, if a stimulus is "on" for 50 mesc and "off" for 50 mesc, then its duty cycle is 50%. When the stimulus is slowed down to 4 Hz, the stimulus now repeats itself every one-quarter of a second or 0.25 seconds (250 mesc). The stimulus is still "on" for 50 mesc, but is now "off" for 200 mesc. The duty cycle is now 50/250 or 20% (refer to Figure 7). This lower duty cycle causes the average light intensity to become dimmer than it was at 10 Hz because the duty cycle (or percent "on" time) is less. Figure 9 shows the average intensity changing with the rate in a fixed pulse-duration system using a pulse duration of 25 msec. Psychologically, the user may notice these increases and decreases in intensity as the frequency changes, which may cause distractions and interfere with the entrainment process. Also, BWE is more difficult to achieve when the duty cycle is too low or too high (refer to Figure 2). Some L&S devices use this fixed pulse width method. This uses less power, which allows the unit to be powered from a smaller battery, such as a 9-volt battery.

The "fixed duty cycle" or "fixed percentage" method is when the stimulus "on" time is set as a fixed percentage of the total time, which includes both the time that the stimulus is "on" and the time that the stimulus is "off" until the next stimulus occurs. With the fixed duty cycle method, the stimulus always has the same percentage of "on" time at any frequency. For instance, using the same example above, but with a fixed-duty cycle, a stimulus at 10 Hz still has a PW of 50%. The stimulus will be on for 50 msec and off for 50 msec. At 4 Hz, the stimulus will be on for 125 msec and off for 125 msec, which is a PW of 50% (refer to Figure 8). With the fixed-duty cycle method, the average intensity or sound volume would stay the same no matter what the frequency. Also, with the fixed-duty cycle you can select the duty cycle that is within the range where BWE is most likely to occur (refer to Figure 2).

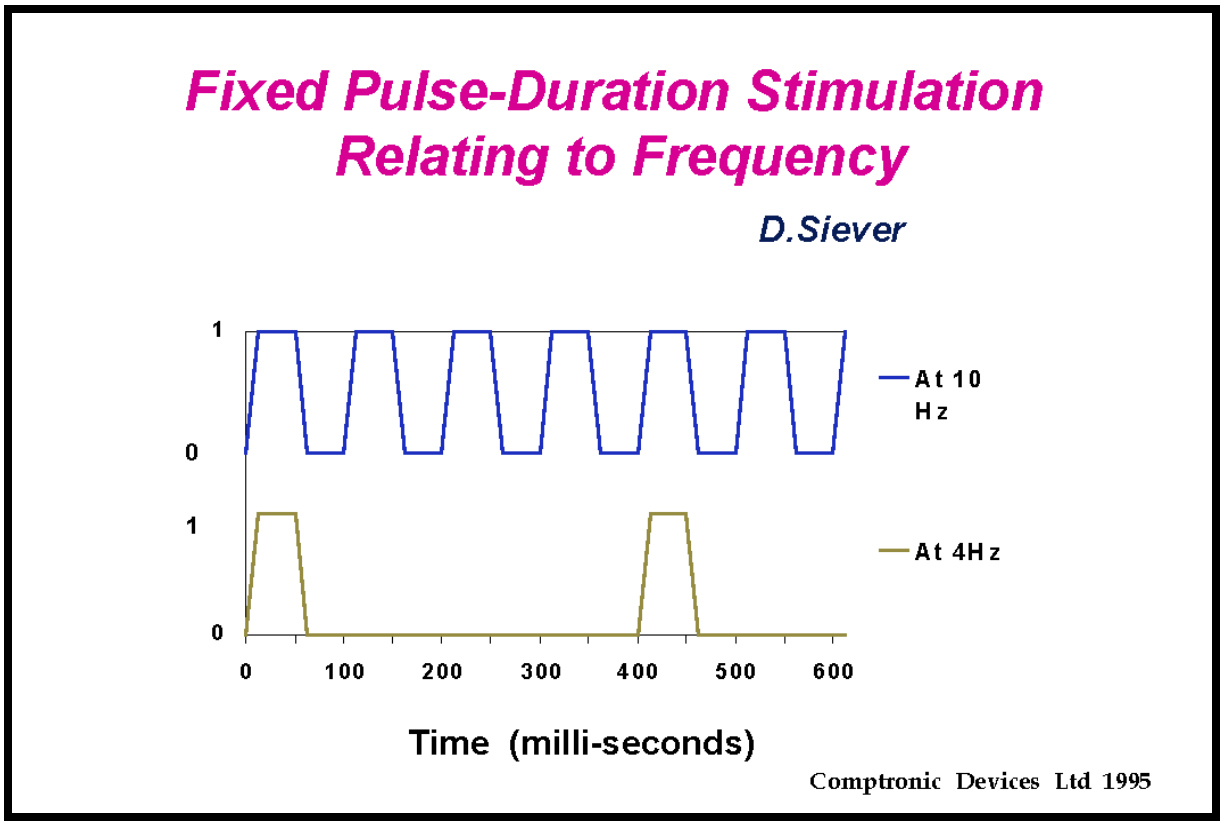

Fixed Pulse-Duration Stimulation
Relating to Frequency
D.Siever
1
0
1
0
At 10 Hz
At 4Hz
0
100
200
300
400
500
600
Time (milli-seconds)
Comptronic Devices Ltd 1995

Figure 7

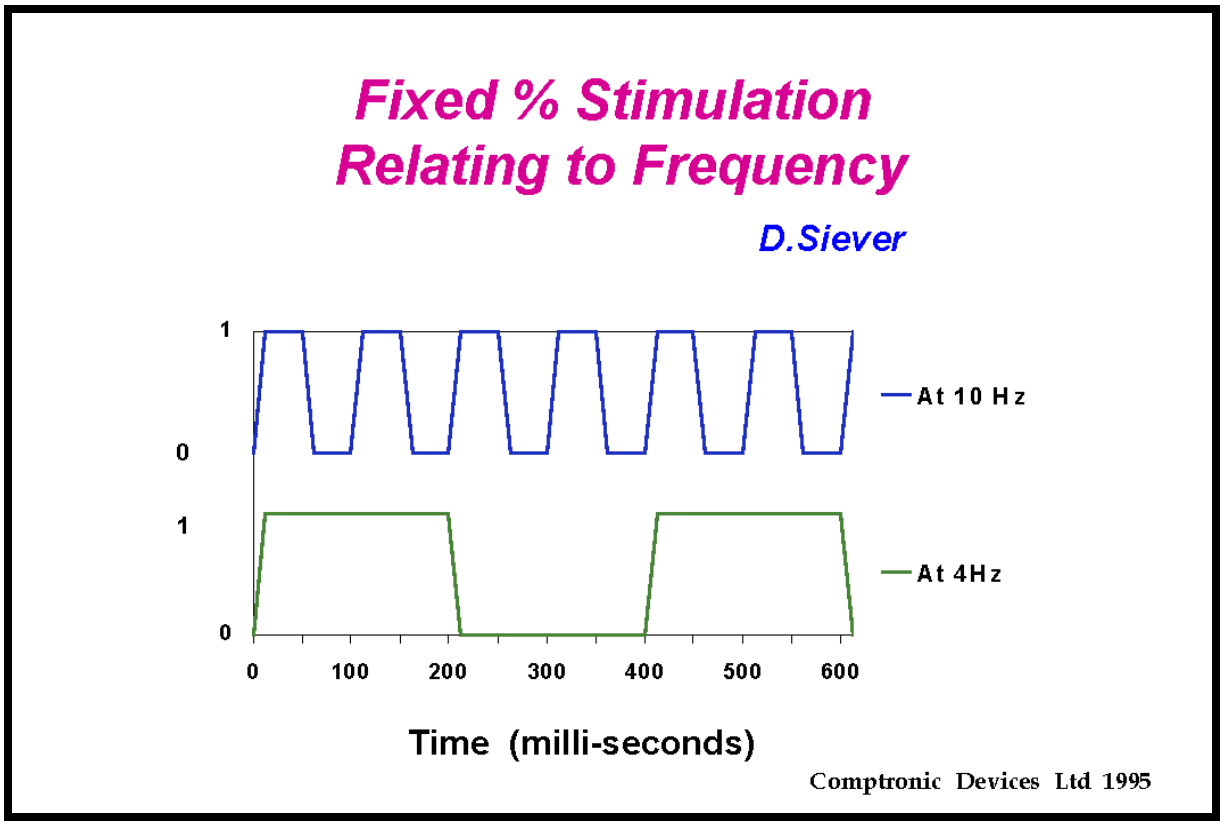

Fixed % Stimulation
Relating to Frequency
D.Siever
1
0
1
0
At 10 Hz
At 4Hz
0
100
200
300
400
500
600
Time (milli-seconds)
Comptronic Devices Ltd 1995

Figure 8

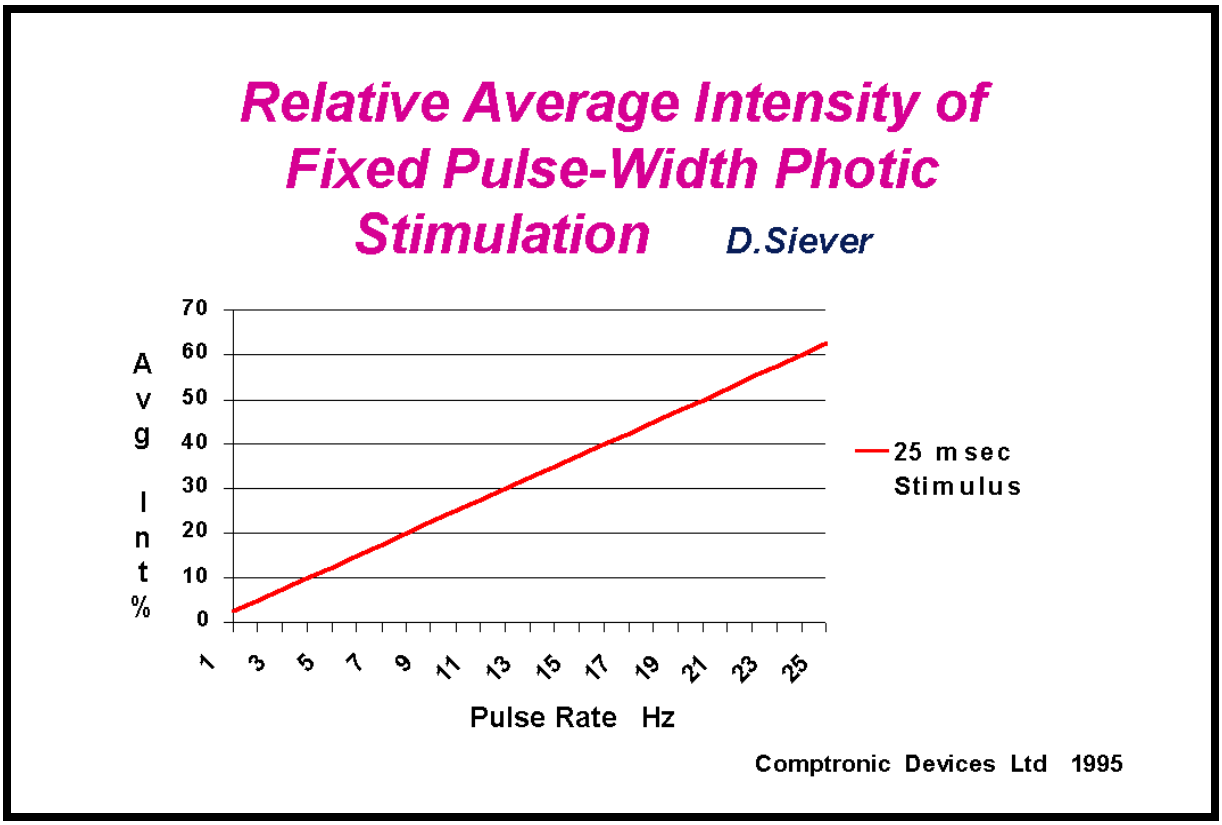


Figure 9

PSYCHOLOGICAL COMPATIBILITY RULES

Where the power, frequency and consistency rules deal with direct cause and effect aspects of BWE, the psychological compatibility rules deal largely with our perception. Some deal with our sensory perception and some deal with our mental perception of the technology, such as our emotional and evaluative thought processes like - "what do we think of this?" In this section, there are fewer rules, and plenty of guidelines.

The Psychological Compatibility Rules are:

A) Soft-Off™
B) Effects of Color
C) Equipment Confidence Guideline

D) "Therapist/Client" Rapport Guidelines
E) Client Comfort Guideline
F) The Guardian Response

A) Soft Off™

Soft Off™ is a process where the intensity of the lights and the volume of the tones gradually fade out to off. Usually this process takes 30 to 90 seconds, depending on the initial eyeset intensity and, to some degree, personal preference.

For centuries, experienced meditators have always been careful not to startle another meditator during meditation because of the nauseous and disoriented feelings that one may experience when being startled. This effect, known as somnatic shock, is the shock to the body that is produced while in a state of somnambulism, or deep hypnotic/meditative state. These uncomfortable feelings are probably caused because conscious protective barriers are not in place during meditation and a "startle" may evoke an "unfiltered" fight-or-flight response.

Very little information seems to be available about somnatic shock and some medical people wonder if the term should be somatic shock, meaning a shock to the body. We prefer to use the term somnatic shock since it describes the situation in which this particular type of shock occurs, whereas somatic shock explains the effect, not the cause.

In 1986, I first observed somnatic shock during BWE with several small LED light and sound devices which shut off suddenly at the end of a session. Some people, who typically had good experiences with the DAVID1 where the DAVID1 operator faded out the eyeset intensity and volume at the end of a session experienced somnatic shock with the small LED units. We set up a small study with 10 people using two alpha sessions, each session one week apart. On one of those sessions, the audio and visual stimulation were faded out while the other session ended abruptly. None of the participants experienced somnatic shock with the session ending with soft off, while six of the participants experienced mild somnatic shock with the session ending abruptly. If a person is going to use a BWE device, it is important that the entire experience is enjoyable, especially the ending.

Soft Off™ was first introduced in the DAVID devices in 1987. This concept has since become an accepted standard in the industry and most manufacturers have followed suit with some method of fading out the stimulus.

B) Effects of Color

The effects of color can have a profound impact on the BWE experience. For instance, the colors blue and green are most effective for calming people with high anxiety or chronic pain. The colors red, orange and yellow increase one's arousal, red often produces a mild anxiety state. Yellow appears to be the best for creative processes. Violet appears to be helpful with philosophical or contemplative thought processes.

Figures 10 and 11 show red light and blue-tinted white light stimulation on galvanic skin response (GSR) and resting muscle tension as measured with an electro-myograph (EMG). Note the increase in sweat-gland (low electrical resistance) and muscle tension caused by red-light stimulation.

Figure 10

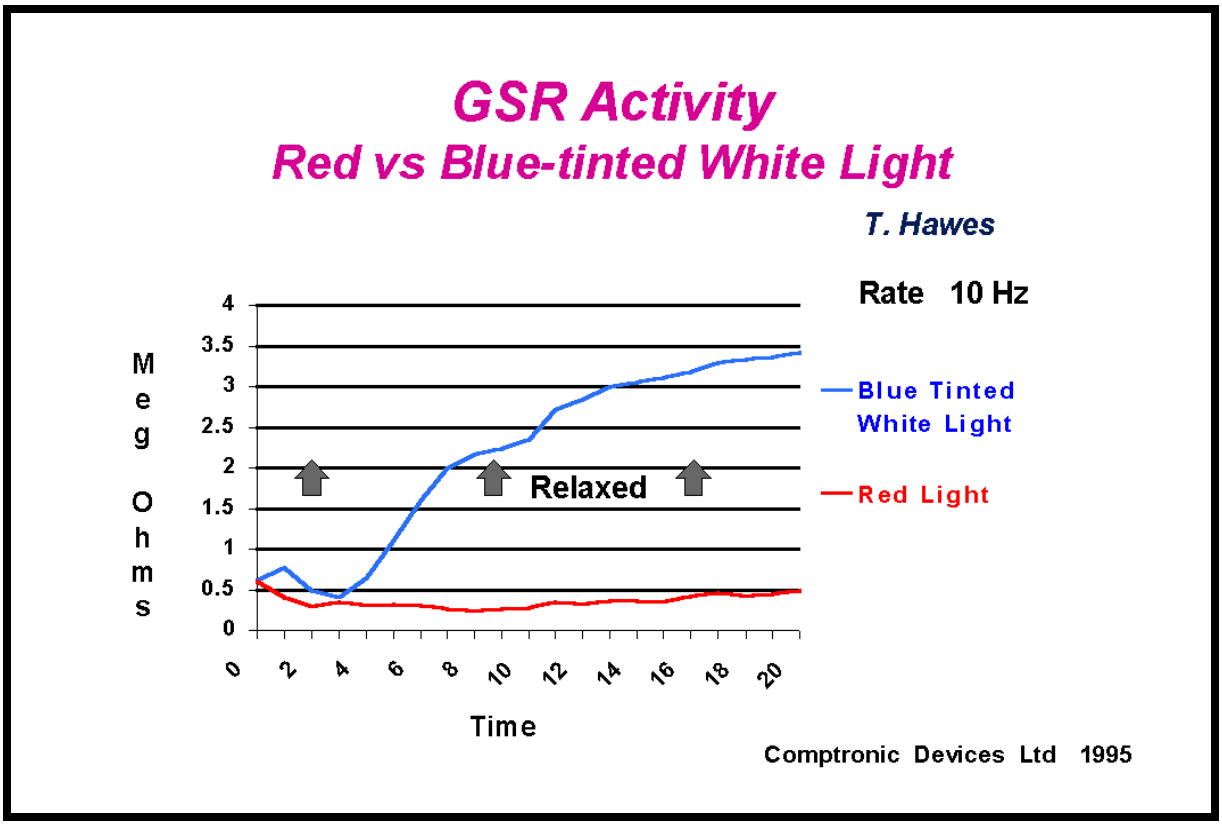
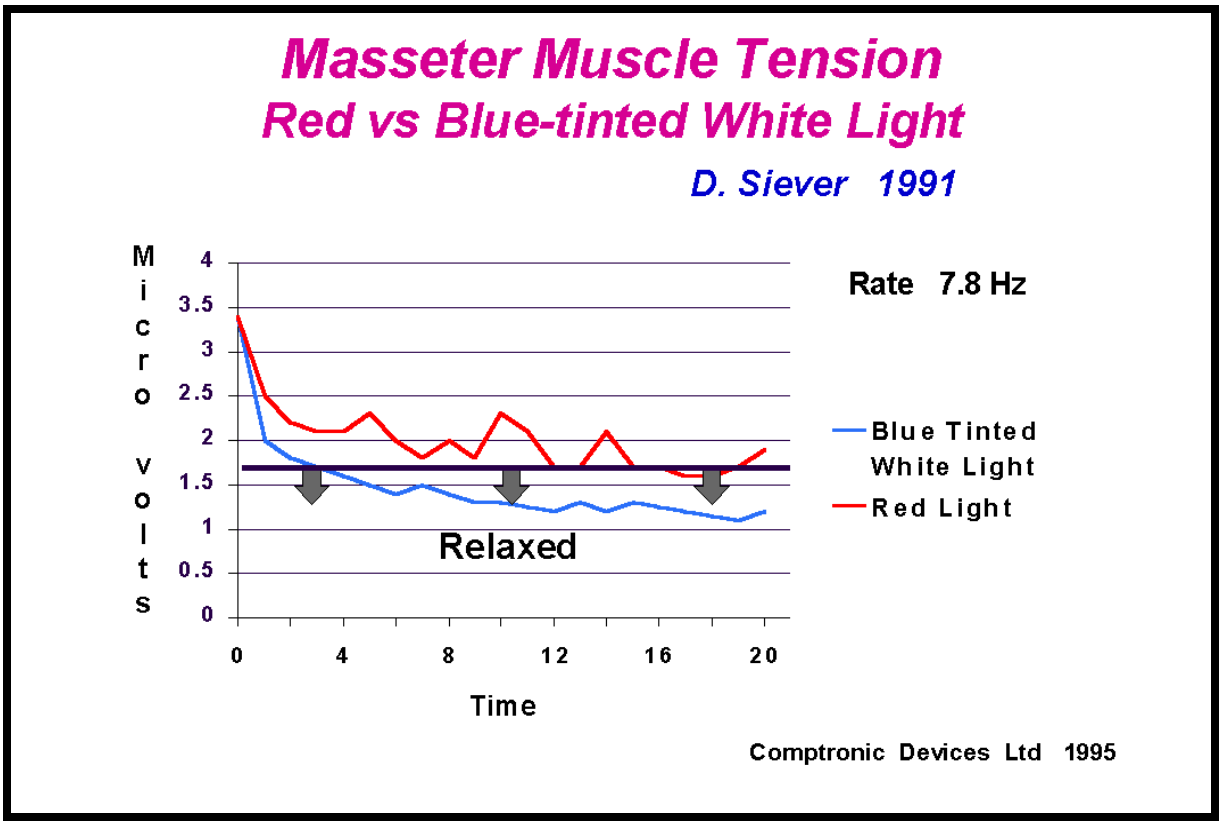

GSR Activity
Red vs Blue-tinted White Light
T. Hawes
Rate 10 Hz
Meg Ohms
4
3.5
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
12
14
16
18
20
Time
Relaxed
Blue Tinted White Light
Red Light
Comptronic Devices Ltd 1995

Figure 11



C) Equipment Confidence Guideline

The quality of the whole AVE experience depends, in part, on the user's confidence in the equipment he/she is using. In order to gain the confidence of the user, it is important that the equipment is of sufficient quality. If the user sees cheap bulbs protruding from the eyesets, an erratically functioning device, or a manual stating something to the effect of "It doesn't matter how this works, just have a good time," the user may develop some apprehension toward the BWE experience.

D) "Therapist/Client" Rapport Guidelines

Although we use the word "therapist," in actuality the person demonstrating the equipment to a customer may not be a therapist at all. He/she may be an employee in a "Brain Gym," a teacher, meditator, or simply a friend who is thrilled about BWE technology. In any instance, these guidelines will cover a few basic points regarding the emotional aspects of BWE.

1) What is the therapist's knowledge of the technology and the equipment?

2) What is the level of convincible expectation on the part of the therapist?

3) How comfortable or safe does the client feel with the therapist?

First, the therapist's knowledge of the technology will reassure the client that there is a scientific basis for the "treatment." In these times, most of us are aware that good "medicine" can extend far beyond a doctor's office and most people are aware that there is plenty of quackery out there also. The therapist should be professional and clients must feel that they are in "good hands". The therapist should believe that the equipment used is the best available. The quality of the equipment will affect the outcome of the session. If the therapist is not confident about the quality of the equipment, the client will sense this. It is important that the therapist understands how to operate and use the controls of the particular device and can explain why a particular session is doing what it is doing. The therapist should know the contraindications of the technology such as photic induced seizures or retrieval of buried traumatic subconscious material. The combination of this knowledge will have a strong positive influence on the client.

Simply by having the knowledge of the research done by Kroger and Schneider with the old Brain Wave Synchronizer, will allow the therapist to be much more certain of the effectiveness of AVE technology. This knowledge will be reflected in his/her confidence level.

The study by Kroger and Schneider also showed that the higher the level of expectation on the part of the client, as conveyed by the therapist, improved the results. This, of course, demonstrates the importance of knowledge. Figure 17 shows the level of persons going into a hypnotic trance from photic stimulation by the Brain Wave Synchronizer. In this study, the authors illustrated that 78% of all people entered into light or deep hypnotic trances within six minutes. Figure 18 shows the influence that a high level of expectation has on the success of an AVE session.

Figure 12

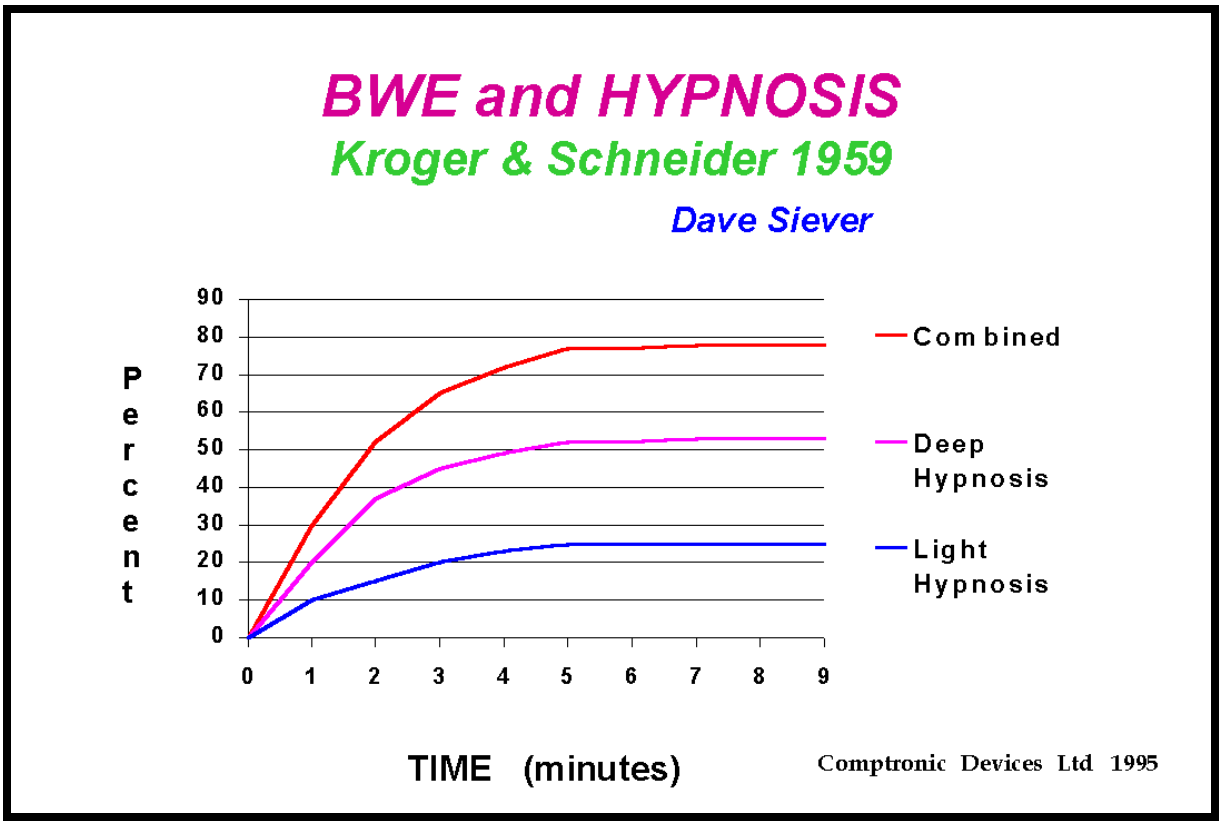
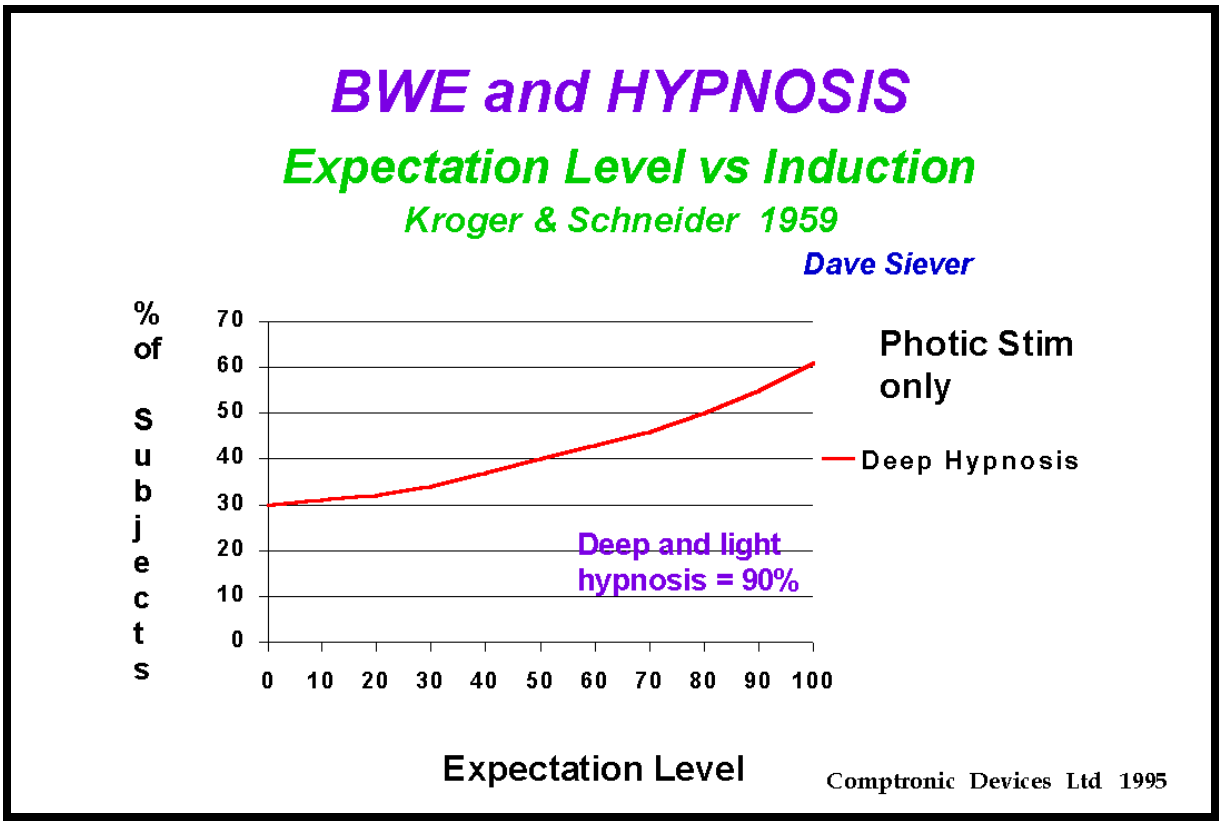

BWE and HYPNOSIS
Kroger & Schneider 1959
Dave Siever
Percent
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
Combined
Deep Hypnosis
Light Hypnosis
TIME (minutes)
Comptronic Devices Ltd 1995

Figure 13



E) Client Comfort Guideline

The most important Client Comfort Guideline is to NEVER let a person use a BWE device while he/she is standing. Research shows that if a person should have a photic-induced seizure, the seizure itself will not cause any harm to the person. The seizure is often not even remembered and may even be a pleasant or euphoric experience. However, if the person is standing when a seizure occurs, he/she may collapse to the floor and possibly sustain injuries from the fall.

Ensure your client is seated or lying comfortably. It helps if his/her shoes are removed and feet are positioned comfortably and tight shirts are loosened. Check that his/her posture is comfortable and that he/she is not slouching. With some people, it is helpful to do a relaxation exercise before the session begins. On the first visit, ALWAYS check to see if the client prefers the focus or expand setting. It may be a good idea to introduce your client to the hemistep function. As the client relaxes, he/she may become chilly. It is a good idea to have a light blanket nearby and it is better to have the room slightly warmer than cooler.

F) The Guardian Response

The guardian response, simply put, is a condition of anxiety that a person may develop when placed into a situation to which he/she feels apprehensive. The guardian response may be produced when a person is in an unfamiliar, uncomfortable setting or where that person is expected to engage in an activity which incites anxiety. Many people have a guardian response to dissociating. Because both L&S and AVE can produce dissociation, they may also elicit a guardian response in some individuals.

Clients may be concerned about being pressured to purchase a product or service, they may have uncomfortable feelings regarding their rapport with their "therapist." Some may feel anxiety about doing a simple task such as performing a math question or even relaxing. A client may be nervous about using the equipment, or may feel too "exposed". A client may be nervous about having "dark" thoughts or may have conflicting religious beliefs, moral values or medical beliefs prohibiting him/her from having a good BWE experience. In any of these cases, the client will probably develop a guardian response which will manifest itself as:

- uneasiness/tenseness
- squirming/fidgeting
- need to visit the washroom
- uncooperative
- refusal to relax
- refusal to drift away during a session
- refusal to complete a session
- high GSR activity
- an immediate "bad" experience
- poor, boring or sickening visuals

Often, an unsettled client can be comforted into having a better experience through conversation or by playing a relaxation tape. If the AVE concept, for some reason, conflicts with the person's belief system, there is typically nothing that can be done except to end the session and thank the person for being there. This person may try a session a year or two later when his/her belief system is prepared for the AVE experience, at which time she/he will likely have an

excellent experience.

At Mind Alive Inc. it is our commitment to provide our customers with superior products that promote a healthier and higher quality of life. We are also committed to providing exceptional customer service.