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VISION & THE ALPHA BRAIN WAVE

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INTRODUCTION

The electroencephalogram (EEG) was first described by Berger (1929). The first ofthe four major components discovered was the Alpha brain wave (ABW), which has a frequency of from 8 to 12 Hz. The other brainwaves are Delta, 0 to 3 Hz, Theta, 4 to 7 Hz, and Beta, 13 Hz and higher. (see Table 1) According to Berger, and subsequently replicated dozens of times, the ABW is larger with the eyes closed, and suppressed when the eyes are open. This phenomenon has become known as Alpha blocking (Mulholland and Peper, 1971, Mulholland, 1974, Jones and Armington, 1977, Ludlam, 1979, and Neidermeyer, 1999)

Figure 1
EYES CLOSED

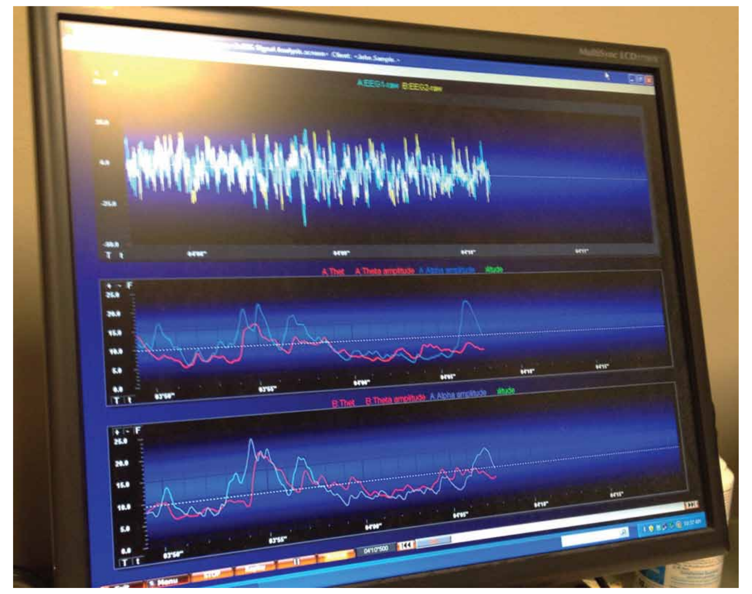
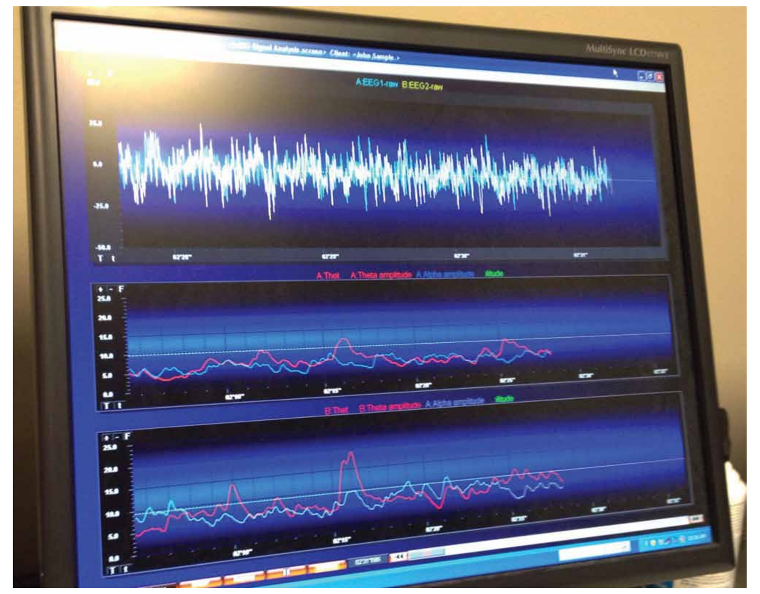


Figure 2
EYES OPEN



Figures 1 and 2 are photos of EEG recordings from O_1 and O_2 On the Figures, the top scale is the raw EEG, the middle scale is from the right occipital lobe, and the bottom scale is from the left occipital lobe. On the middle and bottom scales, the red lines areTheta waves and the blue lines are Alpha waves.

The Figures demonstrate Alpha blocking — reduced ABW activity with the eyes open.

ALPHA CONCEPTS

Past and recent studies have reported that the visual evoked potential is optimized in the Alpha band (Regan, 1977, Nunez et al., 2001, Srinivasan et al., 2006, and Willeford et al., 2013). The ABW can produce a general relaxation response, as well as a number of other physiological and perceptual changes (see Tables 1 and 2). An apparent dilemma, then, is how to utilize the benefits of ABW when there is Alpha blocking?

Table 1
ALPHA BRAIN WAVES, PERFORMANCE & LEARNING

FUNCTION ASSOCIATED WITH ALPHA	DATE & REFERENCE
creativity	1974 Martindale & Armstrong
reaction to stress situations	1974 Maciejczyk & Terelak
creativity	1975 Martindale & Hines
anxiety & neuroticism	1976 Terelak
vision system	1977 Regan
memory, learning, health	1978 Silva
vision funtion & parallel processing	1990 Trachtman
memory & attention	1993 Klimesch et al
parallel processing, enhanced performance	1994 US Patent 5, 374,193
memory process	1997 Klimesch
motor coordination & training	1997 US Patent 5, 597, 309
sensory, memory & motor processes	1997 Başar et al
memory performance	1998 Vogt et al
visual attention	1998 Foxe et al
cognitive & memory performance	1999 Klimesch
driver's education	1999 US Patent 5, 888, 074
cognitive performance	2000 Alvarex et al
functional integrity & cortical flexibility	2000 Putman
enhanced learning	2001 US Patent 6, 206, 700
sensory processing	2001 Schürmann and Başar
vision system	2001 Nunez et al
creativity, performance, anxiety	2003 Hardt
memory	2003 Fingelkurts et al

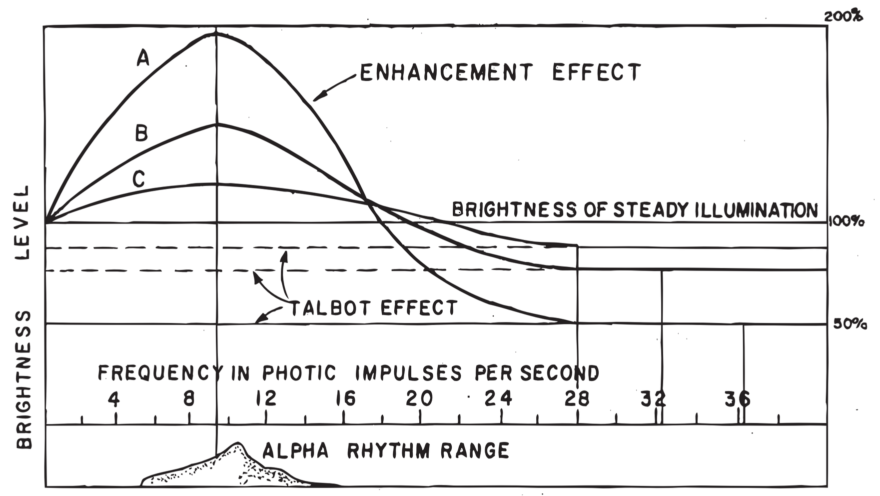
Table 2
ALPHA BRAIN WAVES & PERFORMANCE

ACTIVITY / SKILL	STUDY
gold putting	1993 Crews & Landers
new motor task	1996 Etnier et al
P300 & auditory task	2001 Egner & Gruzelier
expert air-pistol shooting	2001 Loze, Collins & Holmes
musical performance	2003 Egner & Gruzelier
elite marksmen	2004 Hatfield et al
dance performance	2005 Raymond et al
air rifle shooting	2006 Holmes, Collins & Calmels
attention, creativity & memory	2008 Thompson et al
microsurgery	2009 Ros et al

In the 1960's, Allen developed the Translid Binocular Interaction, TBI, which uses the phenomenon of photic driving to induce an ABW state (Allen, 1969). With the eyes closed, two light bulbs, one in front of each eye, flash at a rate of between 4 to 12 Hz, with the optimal rate at 9 Hz. The flashing induced a synchronous rhythm with the EEG resulting in a dominant ABW pattern. The TBI was used to train such vision problems as amblyopia, anisometropia, and strabismus (Allen, 1970).

Credit is given by Allen to Bartley (1939) for his pioneering work demonstrating that lights flashing at between 8 to 12 Hz appear brightest compared to flashes at other frequencies. See Figure 3.

Figure 3
ALPHA RHYTHM VERSUS BRIGHTNESS



METHOD

HYOTHESIS

The hypothesis that is proposed is that accommodative relaxation can stimulate enhanced Alpha brain waves with the eyes open. The suspected mechanism is the sympathetic nervous system feedback loop between the eye , in general, and the ciliary muscle, in particular, and the hypothalamus (Trachtman, 2010).

METHOD
Patients: The patient was male, Caucasian, age 35 years.

Instrumentation: The EEG's were measured using a NeXus 10 EEG unit (Mind Media BV), and accommodation was trained with the Accommotrac® Vision Trainer (AVT) (Biofeedtrac Inc.).

Procedure: The EEG was measured from O1 and O2. After a baseline of ten minutes, the patient was told to close his eyes to assess the ABW amplitude. Following the EEG baseline, the patient was given 20 minutes of accommodative relaxation with the AVT.

RESULTS

Once there was an relaxation of the ciliary muscle, there was an increase in the ABW with the eyes open.

Figure 4 shows the baseline EEG, with Alpha and Theta brain waves approximately equal in amplitude. Figure 5 shows the EEG an increased Alpha brain wave following biofeedback to relax the ciliary muscle. Post accommodative training, the Theta waves remain approximately the same amplitude was measured during the baseline EEG.

Figure 4
BASELINE EEG

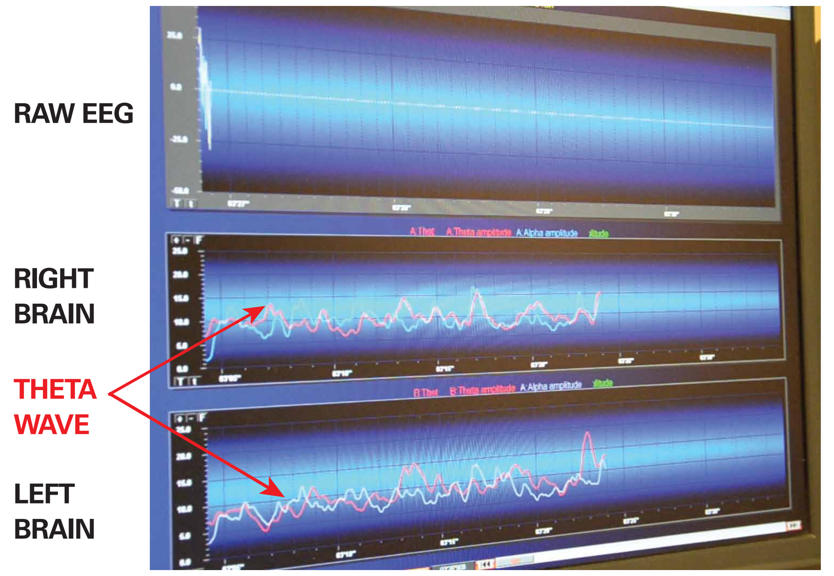
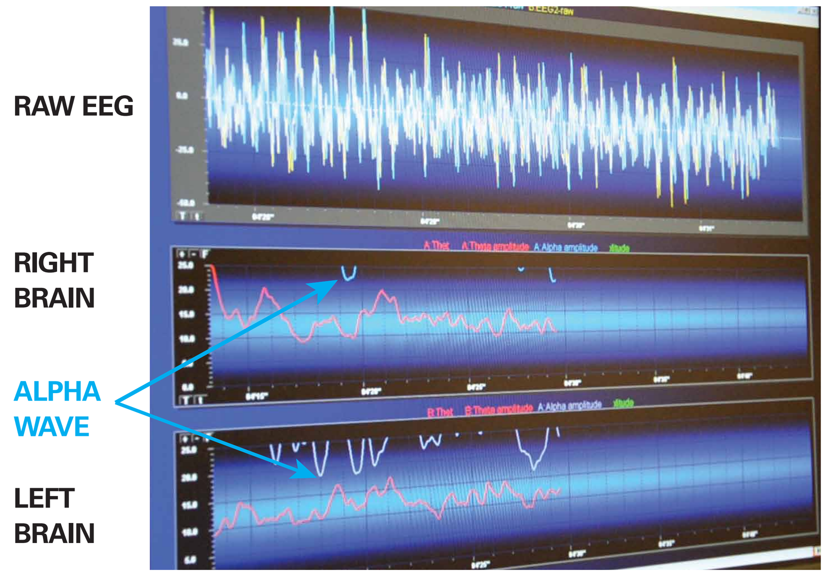


Figure 5
INCREASED ALPHA



While the AVT is a biofeedback instrument, there are other waves to stimulate enhanced Alpha brain waves. Currently available "light-sound" devices, upscale versions of Allen's TBI, can stimulate an increased Alpha brain wave with the eyes open or closed. There are self-help programs, such as Silva Mind Control, and Open Focus, that teach techniques to increase Alpha brain wave activity.

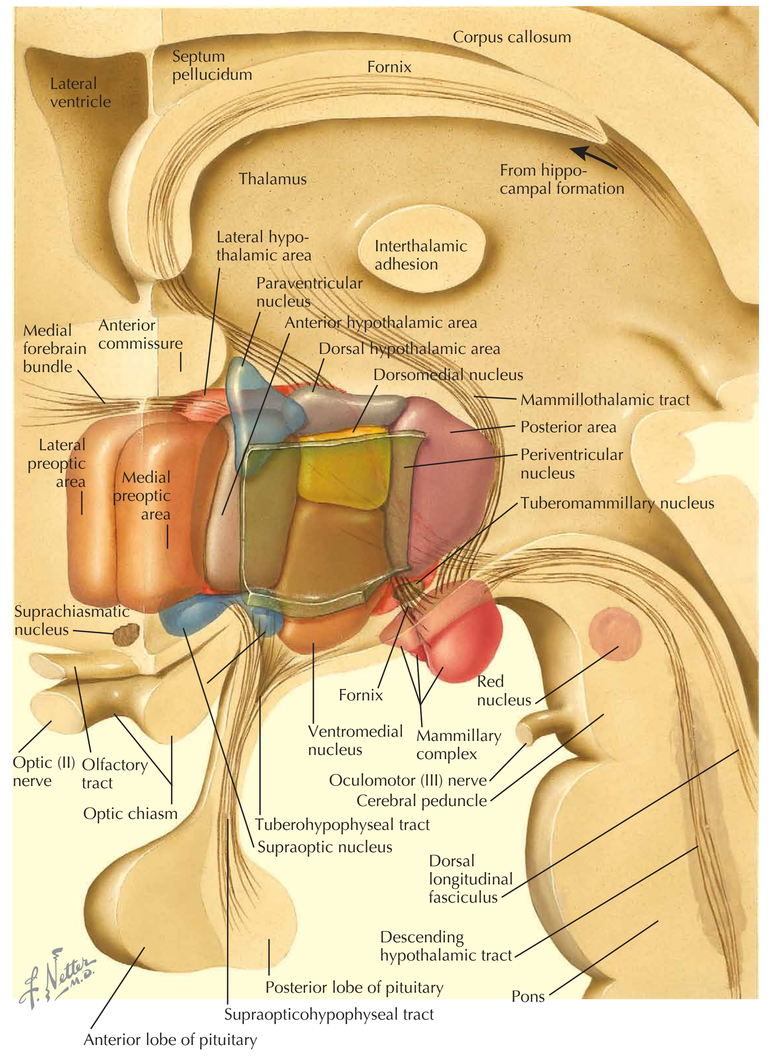
CONCLUSION

Why is the Alpha brain wave important to the optometrist? With an increase in Alpha brain activity there can be an improvement in visual acuity, color vision, contrast sensitivity function, depth perception, the size of the visual field, reaction time within the increased visual field, and binocular vision function.

As optometrists, what can be done to increase the Alpha brain wave? A sustained optimal relaxation of accommodation will produced an increase in the Alpha brain wave. The fastest and most effective method is via training of accommodative facility, which may explain the benefits of low plus lenses (Greenspan, 1970, Pierce, 1970, and Trachtman, 1990).

The changes in physiology can be explain by the eye's unique relationship with the hypothalamus (Trachtman, 2010). Sympathetic nervous system fibers originating in the hypothalamus supply ciliary muscle relaxation (negative accommodation). There are three retinohypothalamic tracts (RHT) from the retina to the hypothalamus. The origin of the RHT occur at different stages of retinal processing, and terminate at different components of the hypothalamus. Among other hypothalamic functions is the regulation of the EEG mediated via the reticular activating system and the nucleus locus coeruleus. Following this sequence of neurophysiological stimulation there are the numerous improvement in functions and performance as listed in Tables 1 and 2. See Figure 6

Figure 6
OVERVIEWOF HYPOTHALAMIC NUCLEI



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