ALPHA EEG FEEDBACK: CLOSER PARALLEL WITH ZEN THAN WITH YOGA

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Major Purpose. Peak performance requires a special state of intense concentration or absorption. This state of unusually intense absorption requires increased EEG alpha activity (Allman, 1992). Allman reports that just before an athlete's best shots the athlete has a big burst of alpha brain wave activity. This increased alpha before peak athletic performance has been measured in basketball players before free-throws, golfers before they putt, and archers and marksmen before they shoot. Alpha brain wave feedback training can teach athletes how to enter this state of intense absorption or concentration, and this ability can then enhance their athletic performance. In a 16 week college archery course students had their brain waves measured before and after the course. Those students who became good archers developed the ability to produce big bursts of alpha brain waves just before their shots. With alpha feedback training, this naturally developed ability can be developed much further to produce Olympic quality performances. In addition the feedback assisted development of alpha wave activity can support and enable improved performance in athletes who somehow fail to develop the increased alpha through their normal training exercises.

How can we best begin to understand peak performance, high alpha states, and alpha feedback training? Perhaps by studying meditation, which has long been known to increase alpha in both Yoga (Wenger & Bagchi, 1961; Anand, Chhina, & Singh, 1961) and Zen (Kasamatsu & Hirai, 1966; Hardt, Timmons, Yeager, & Kamiya, 1976). In the Zen studies, beginners showed increases of alpha activity; intermediate meditators showed increases of slow alpha, and advanced meditators showed emergence of rhythmic theta waves, unlike the theta of drowsiness. Differences between Zen and Yoga in the alpha blocking response to stimulation were seen in reports by Anand, et al. (1961) and Kasamatsu & Hirai (1966). These EEG differences (no blocking in Yogic Samadhi, and continued blocking without habituation in Zazen) suggested comparison with differences in Zen and Yoga philosophies. Yoga philosophy is more likely to deny or devalue external reality in favor of the "real" or superior reality within. When absorbed in the Samadhi of Yoga meditation, external stimulation was ineffective in blocking alpha. The external world had little or no effect on the Yogi's EEG. This is consistent with the beliefs of Yogic philosophy, in which the external world is held to be mere illusion, or *Maya* in Sanskrit.

On the other hand, Zen philosophy seeks to bridge the inner and outer worlds, neither denying nor reifying either the inner or outer realities. Yoga meditation is done eyes closed in most traditions, and the mind is fully absorbed with inner events, to the exclusion of the outer world of the senses. On the other hand, Zen is typically done with the eyes half open, downcast, with soft focus (i.e. blurred or defocused vision). This visual strategy could help Zen bridge the gulf between inner and outer worlds. We might well wonder which of these two meditation traditions is more like alpha feedback training. The Yogic absorption into inner experience would tend to ignore stimuli from the world of the senses, including even feedback sounds (and scores) signaling alpha waves. On the other hand, the Zen acceptance of sensory input (even distractions), and their integration into a steady inner awareness, would seem more compatible with the sen-

sory processing requirements of the alpha feedback setting. Indeed, the requirement of the alpha trainee to open his or her eyes for several seconds every 2 minutes to view the digital feedback scores may be more compatible with Zen than with Yoga practice. It would therefore seem more suitable to compare the alpha feedback changes to those seen in Zen mediation. When taken together, the studies of Kasamatsu and Hirai (1966) and Hardt, et al. (1976), **show Four Zen EEG changes: [1]** Control Ss show no alpha increases, **[2]** Beginner Zen Ss show increased alpha amplitude mainly at the back of the head (Occipitals), **[3]** Intermediate Zen Ss show increased alpha amplitudes which spread forward on the head, and which slow in frequency, **[4]** Advanced Zen Ss show the above changes, but in addition also show rhythmic trains of theta EEG, which are morphologically different from the theta of drowsiness. The theta wave criterion is a stringent one for alpha feedback, since only advanced Zen with 21-40 years showed it.

Subjects. 17 *Ss* were selected at random from a large University psycho-physiological data base of EEG alpha feedback training. Criteria included right handedness, at least 7 days of alpha feedback training. All Ss were volunteers, who did not have any meditative practice, Zen, Yoga, or otherwise.

Method (Equipment). All EEG data were collected with **Biocybernaut Institute** Mark 5A Hybrid Spectral Analysis systems, with 64 channel 12 bit A/D converters. Input to the A/D was provided by 8 EEG amplifiers, each with 8 analog filters. The filters were very sharp (300-400 dB/octave roll off, and 1/3 dB ripple in the pass band). The filters provided delta, slow 1/2 of theta, fast 1/2 of theta, slow 1/3 of alpha, broad band alpha, fast 1/3 of alpha, slow 1/2 of beta, broad band beta signals on each of the 8 EEG channels: bilateral Occipital, Central, Temporal, and Frontal (O1, O2, C3, C4, T3, T4, F3, F4). The smoothed, full wave rectified filter output was input to the A/Ds. Four channel feedback was provided simultaneously from broad band alpha at the Occipital and Central sites (O1, O2, C3, C4), while the Temporal and Frontal sites were only passively recorded (i.e. no feedback). Recording was monopolar to linked ears reference.

Method (Procedure). Every effort was made to follow recommended procedures for successful alpha enhancement training (Hardt, 1974, 1990). *Ss* had 7 consecutive days of alpha feedback training. Each day had eyes open, eyes closed and white noise baselines. Alpha enhancement training times were 60 minutes on days 1-2, 90 minutes on days 3-4, and 120 minutes on days 5-7, with the option given to trainees to do additional alpha enhancement on days 5-7. Alpha feedback was both audio tones and digital scores (visual). There were 4 tones from 4 spatially separated speakers (from O1, O2, C3, C4), with tone volume proportional to instantaneous amplitude of the alpha envelope. Feedback tones operated for 2 minute intervals, then were interrupted for 8 seconds of digital display of integrated amplitude alpha scores from each of the 4 feedback sites. Then score displays turned off and tone feedback resumed. After each session, an experienced trainer asked for subjective reports and gave a review of results.

Results: Determination of Cumulative Change Scores and *t*-testing. Sets of change scores were calculated, separately for each of the 17 *Ss*, on each of the 7 days of training. Each set had 64 change scores (8 head sites with 8 filters at each head site). Each change score was the difference between a given day's average score during the task of alpha enhancement (minuend), and the corresponding average score during the first day's pre-feedback white noise baseline (subtrahend). Thus each change score of each *S*, on each of the 7 days, reflected a given head site's and a given filter's change from the baseline level on day 1 (before any feedback training). When these change scores for each *S* were collapsed across all 7 days of training (by summing), they became Cumulative Change Scores, and each *S* had 64 of them (8 EEG channels each with 8 filters). These Cumulative Change Scores were then *t*-tested across the 17 *Ss*. If the *t* was significant and the average change score was positive, then there was a significant **increase** in that EEG parameter for the group of 17 *Ss*. A significant t with a negative average change score meant a significant **decrease** in that EEG parameter for the group.

All 8 head sites (O1, O2, C3, C4, T3, T4, F3, F4) showed significant [$p<.05$] increases of both broad band alpha and slow alpha. In addition, there were significant increases of both fast theta and slow theta at the two Frontal sites (F3 & F4), and the levels of significance were all higher than $p<.01$, with the highest levels of significance ($p<.0025$) seen in the fast theta, which is closer to the alpha frequencies. Beta and delta changes were not expected, and few were found. Only 3 of the 8 head sites showed any significant beta changes (O1, C4, & T3), and these were small increases. Only one site showed any delta changes (C3), where there was a significant decrease of delta activity.

Discussion. One possible interpretation for the 3 widely scattered beta increases (O1, C4, T3) and the one delta decrease (C3), is a slight upward shift of arousal (away from drowsiness), relative to the eyes closed white noise baseline. The occurrence of such an upward arousal shift at the upper and lower limits of the EEG spectrum, while there was simultaneously a slowing of alpha and

the emergence of Frontal theta could suggest considerable complexity and subtlety in the relationship of the EEG to the arousal continuum. Other effects were seen more uniformly across the head. It is quite remarkable that all 8 head sites showed significant increases of both broad band alpha and of slow alpha activity. Remarkable for two reasons: **[1]** Only 4 of the 8 sites provided feedback signals to the Ss, suggesting extensive generalization of the feedback increases of alpha, and showing that localization-of-control to near the feedback sites was not developing. This can probably be attributed to the use of four simultaneous feedback sites. **[2]** In Zen meditation it took 6-20 years of practice to reach the stage of increases in slow alpha and the alpha spreading forward toward the Frontals. Beginners with 0-5 years of experience did not show either the slowing or anterior spreading alpha activity. Technology speeds things up, and EEG feedback may accelerate the processes of intense concentration, inner focus, and self control seen in Zen meditation. **There is yet one further consideration: the Frontal theta increases.** Only those advanced Zen meditators with **21-40 years** of experience showed theta activity in their meditation records (this theta alternated with their slowed alpha activity), and yet the **7 day** alpha feedback trainees showed this same result. The alpha trainees had highly significant increases of both fast theta and slow theta activity at the Frontal sites (F3 & F4).

We now have the opportunity to integrate 3 areas of knowledge: [1] The current findings that alpha feedback can produce patterns of EEG changes seen in the most advanced Zen meditators (both alpha and theta changes). **[2]** Hardt & Kamiya's (1978) alpha feedback report that learned increases in alpha will reduce stress and anxiety. **[3]** Allman's (1992) report that certain patterns of increased alpha (and sometimes theta) precede, and appear to enable, moments of peak performance.

Future alpha and theta studies may see benefits in design, execution, interpretation, and application from greater understanding of Zen philosophy, Zen practice, and the Zen progression of mind states from Beginner's mind, through kensho, culminating in satori. Learning to extend one's moments of peak performance (staying in the "Zone") through properly designed programs of EEG feedback training is now a realistic goal. Slightly more difficult, is the goal of learning how to enter the "Zone" whenever peak performance is required. Attainment of these goals is possible through intensive alpha brain wave feedback training, which promises the rewards of peak performance for athletics, business, science, education, government, the arts, and perhaps in every area of human endeavor where people are in search of excellence.

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