A BRIEF REVIEW OF RESEARCH AND CONTROVERSIES IN EEG BIOFEEDBACK AND MEDITATION

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EEG BIOFEEDBACK RESEARCH

One important early psychophysiological research study of consciousness using EEG biofeedback techniques was that of Joe Kamiya (1969) where he suggested that by using biomedical electronics it was possible for individuals to simultaneously observe their electroencephalogram (EEG or brain waves) as they also attended to the flow of inner experience. Kamiya also indicated that it was possible through this biofeedback technique for individuals to alter and control their brain wave patterns. Finally, he suggested that this technology might offer a way to learn to enter the states of mind described by various Eastern meditative disciplines.

could subjects learn to control alpha rhythms?

For several years (1969-1978) it was debated in the scientific journals whether experimental subjects could learn to control alpha rhythms. Following the initial enthusiasm generated by EEG alpha biofeedback research, Orne and Wilson (1978) described what they viewed to be serious methodological questions in all the previous alpha enhancement research. They primarily referred to a study by Lynch, Paskewitz and Orne (1974) who found that subjects seated in a dimly lit room with their eyes open were unable to learn to increase their alpha levels above their baseline alpha levels recorded in a darkened

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room with eyes closed. This single negative finding may have had more to do with the decrease in scientific interest in BEG alpha biofeedback than any other single factor.

In examining the Lynch, Paskewitz and Orne (1974) study it becomes clear why they had negative findings. The total alpha enhancement training time in this study was 22 minutes. Ancoli and Kamiya (1978) suggested that studies that failed *to demon*strate that subjects could enhance alpha activity had one or more methodological flaws. They suggested that negative findings could be explained by: (a) too few training sessions, (b) the use of dichotomous feedback rather than continuous feedback, (c) and training sessions of too short duration. By the time of the Ancoli and Karniya (1978) publication, most scientific investigators had written off the area of EEG biofeedback training.

More recently, Shellenberger and Green (1986) have reached similar conclusions regarding the methodological factors that lead to successful biofeedback training. In fairness to Lynch, Paskewitz and Orne (1974), their baseline recording procedure for assessing initial maximal alpha levels in no manner should limit any researcher from using their optimal training techniques to demonstrate above baseline alpha enhancement. To our knowledge, no published research has reported such a finding.

self regulation techniques and biofeedback training

Shellenberger and Green (1986) found that all the successful biofeedback studies that they reviewed taught self-regulation techniques in conjunction with biofeedback training. The controversy regarding whether subjects can learn to enhance EEG alpha above eyes closed baselines may be resolved when subjects who are naive to meditation techniques are given EEG biofeedback training as well as instruction in different self-regulation and meditation techniques. What may be of importance is not whether people using BEG biofeedback in isolation can enhance EEG alpha. but rather, what mix of biofeedback and meditative techniques best facilitates the acquisition of self-regulation of desired states.

It is noteworthy that just as the interest in EEG alpha biofeedback was waning in the biofeedback and psychophysiology scientific community. the EEG and meditation research area was being recognized as an important area for consciousness research. One reason for this recognition was that meditation appeared to alter the EEG while the impact of biofeedback to alter the EEG was in doubt. An underlying difference in these two research areas which has always existed is the total amount of time subjects were able to practice self regulation.

EEG alpha biofeedback research subjects, because of their dependence on the biofeedback instrument, were only able to practice self regulation during their research sessions and as a consequence might have shown little self regulation ability. EEG and meditation research subjects were able to practice self regulation on their own and during research sessions. With sufficient over-all practice time, meditation subjects often showed EEG changes during meditation sessions. We will discuss the findings of a few meditation studies that represent some of the EEG differences found across meditative techniques.

EEG and Meditation Studies

Das and Gastaut (1955) found in an EEG study of seven yogis that as the meditation progressed the alpha waves gave way to fast-wave activity at the rate of 40 to 45 cycles per second and these waves in turn subsided with a return of the slow alpha and theta waves.

Anand *et al.* (1969) in India found that yogis showed a heightening of alpha activity during meditation.

Hirai's studies of Zen masters

Hirai (1974) examined 48 Zen masters (14 Rinzai, 34 Soto) from 40-72 years of age and Zen training from 22 to 55 years. For both sects he found four EEG stages to unfold during meditation practice: Stage 1) appearance of alpha waves at the initial stage of meditation with eyes open, Stage II) increase in alpha amplitude, Stage III) decrease of alpha frequency, and Stage IV) appearance of rhythmical EEG theta activity in the final stage of meditation.

Arousal influences have to be examined in EEG and meditation research to rule out the possibility that the EEG changes observed are not due to shifts in arousal due to drowsiness. In normal subjects not experienced in meditation such shifts to drowsiness are often signaled by low amplitude EEG theta activity (Echenhofer, 1985). The EEG arousal literature had indicated that 1) subjects in drowsy states showed an increase in alpha activity with the presentation of sensory stimulation, and 2) subjects in an alert state showed a diminution of EEG alpha or what is called "alpha blocking" with the presentation of sensory stimulation (Echenhcfer, 1985). Hirai provided evidence that the theta activity he observed was not drowsiness. Hirai found that the EEG theta activity exhibited by advanced meditators was blocked by stimulation and reappeared after several seconds suggesting the meditators were not in a drowsy state.

Aging influences also alter the EEG across the life span, decreasing the frequency of the EEG by about .25 cycles per second per decade after twenty years of age (Echenhofer, 1985) and increasing EEG variability (Echenhofer, 1981). Aging influences also increase the variability of the reactivity of the EEG to sensory stimulation (Echenhcfer, 1980). By examining the EEG characteristics of control subjects matched by age to the meditation group, Hirai was able to provide evidence that the dramatic EEG changes associated with meditation were unlike the chronic EEG alterations associated with age.

Hirai's studies of Zen disciples

Hirai (1974) also examined 98 Zen disciples who were under the guidance of the above mentioned 48 Zen masters. Hirai classified these disciples according to years of training: Group I included 42 disciples with 1-5 years of training; Group II included 3J disciples with *6·W* years of training; and Group III included 25 disciples with 11-15 years of experience. Group IV consisted of the 48 Zen masters.

Hirai selected 23 subjects from the disciples' group that most repeatedly demonstrated consistent EEG changes during meditation. These 23 were classified by ERG changes in meditation and by years of training. These results appear in Figure *I* from Hirai (1974). A very clear relationship between Hirai's four EEG stages and years of training was demonstrated.

FIGURE I

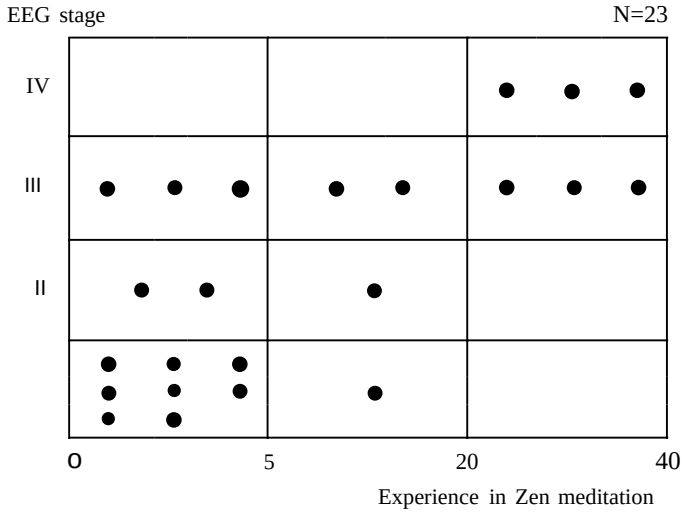

Figure I. The relationship between the state of EEG changes (I-IV) and the disciples' years spent in Zen training (from Hirai, 1974)

These same 23 subjects were classified by their Zen masters in terms of the level of Zen practice they had reached (Low,

Middle, or High). Figure 2 shows Hirai's findings of the relationship between EEG changes observed during meditation and level of Zen practice.

FIGURE 2

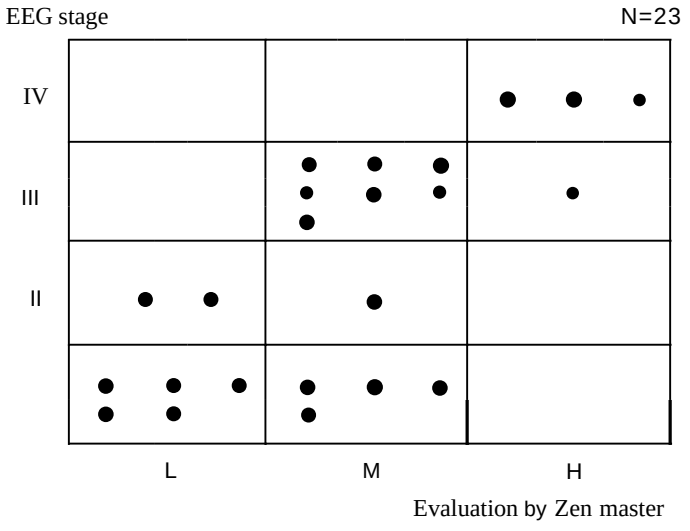

Figure 2. The correlation of EEG stage (I-IV) with the disciples' mental state, which was evaluated by the Zen master, classified as low (L), middle (M), and high (H). The close relationship is recognized between both. (from Hirai, 1974).

EEG and developmental process

Hirai has provided remarkable evidence that for Zen practice, EEG is highly related to the developmental process of the unfolding of awareness as assessed by Zen masters.

Using more sophisticated EEG analysis techniques Banquet (1973) examined subjects practicing Transcendental Meditation and found EEG changes, including slow, high-amplitude alpha activity extending into the frontal lobes, theta activity different from sleep, and rhythmic amplitude-modulated beta waves over the whole scalp. These findings support the findings of Hirai (1974), Anand *et al.* (1969) and Das and Gastaut (1955). In addition, Banquet (l973) observed that the alpha frequencies were synchronized between frontal and occipital EEG placements. Increasing synchronization or coherence in the EEG refers to a relationship among various EEG recording sites. EEG alpha synchronization indicates that over specified areas the alpha frequencies recorded are reaching their positive and negative deflections at the same moment in time,

Fehmi (1978) used a structured meditation technique called Open Focus Training. He monitored five EEG locations and attempted to measure changes in EEG alpha amplitude and synchrony. **In** this manner, Fehmi has combined more sophis-

ticated biofeedback procedures with the learning of a meditative technique. Although this approach is dearly justified when considering the findings of the biofeedback and meditation literature, Fehmi's biofeedback procedures yield a composite biofeedback signal. This signal represents the summation of both amplitude and synchrony factors from any sub-set of the five channels recorded. With such a measurement procedure specific information regarding the location, synchrony, and amplitude of the EEG is unavailable for research or biofeedback purposes.

EEG laterality and meditation

The multiple channels of EEG using sophisticated EEG analysis techniques required by meditation research are also required for EEG cerebral laterality research. Earle (1981) reviewed the EEG laterality and meditation literature. Although no research studies have specifically examined EEG laterality and the learning of meditation, Earle based his conclusions primarily upon research in: I) the EEG of meditation, 2) cerebral *laterality,* 3) EEG, performance, and meditation, and 4) the subjective description of meditative states. Earle suggested the following regarding the role of the right hemisphere in meditation: I) beginning meditators may be learning to control attention. inducing relative right hemisphere activation; 2) beginning meditators vary in the degree of cerebral asymmetry exhibited probably according to type and object of meditation as well as individual differences; but 3) each hemisphere is inhibited for advanced meditators, producing symmetrical high amplitude slow frequency EEG in both hemispheres. In short, Earle has suggested that the tight hemisphere might be involved during the learning of meditation techniques, but neither the right nor left hemisphere is activated during the advanced stages of meditation practice. For Earle's (1980 views regarding EEG laterality and meditation to be substantiated, future research requires developmental designs where beginning meditators are examined over the course of the development of their meditation practice.

CONTROVERSIES REGARDING EEG, MEDITATION, AND CONSCIOUSNESS

controversial issues

Research in meditation and EEG has established a meaningful link between EEG and states of consciousness, Nonetheless, at the present time, several controversial issues arise when addressing the study of EEG and consciousness. Some of these issues can be expressed in the following related questions: I) What can the scientific understanding of meditative states provide to the practice of meditation? 2) Can EEG monitoring or EEG biofeedback further meditative practice? 3) What can EEG

technology offer to the development of transpersonal psychology? 4) What is the proper world view or paradigm to incorporate the use of an electronic technology toward an end that is spiritual in nature?

From the perspective of the authors there have been several impediments to the progress of EEG consciousness research:

limitations in technology

I. The first impediment to the progress of EEG consciousness research has been the limitation in technology. One can only appreciate in a limited way the sound of an orchestral composition listening through a thick wall with a glass to one's ear. The state of the art of EEG technology has had serious limitations up to the present time. Recent advances in EEG technology more suited to the complexity of consciousness research are now at hand. Twenty channel EEG spectral analysis with color topographic displays of amplitude, frequency, or coherence information in real-time is available with current technology to use for monitoring meditative states or to use interactively for biofeedback assisted meditation.

uncertainty regarding the appropriate paradigm

2. The second impediment to the progress of EEG consciousness research is the current uncertainty regarding the appropriate paradigm for the advancement of knowledge about consciousness. Although Ken Wilber (I 983) has provided very needed philosophical and methodological grounding for the emerging discipline of transpersonal psychology, in his discussion of EEG and consciousness research he has not recognized the importance of the potential of this area.

Ken Wilber (1983) has suggested that the use of the EEG to monitor higher states of consciousness is misguided when empirical physiological evidence is advanced as "proof" of transpersonal states. An empiricist's response to Wilber would undoubtedly be to say that certain experimental results either support or do not support hypotheses, and that a discussion of proof is.not at issue. However, since the empiricist is using hypothesis testing as a method of verification, it is close to what we mean by proof from a common sense perspective.

Wilber (1983) has described Ornstein's (1972) survey of the EEG and meditation research as an example of such a misguided use of EEG research. In our reading of Ornstein (1972) we find no specific claims of empiric-physiological evidence offered as proof of transcendental states, rather the physiological findings are presented as correlated with meditative states. Ornstein does suggest that it might be profitable to view the physiology of meditation in light of what we know empirically about psychophysiological habituation to stimuli. Trying

to draw links between the physical and transcendental domains is not the same as reducing the higher order domain to the lower order domain. It is not reductionism as Wilber claims. A reductionistic analysis would claim that the higher order domain is fully explained by the lower order domain. No such claims have been made. In discussing EEG biofeedback, Ornstein (1972) has stated, "the current developments in feedback training hardly are in the same league with the procedures of *the* esoteric traditions."

Wilber concedes that if we assume that a particular individual is competent to enter and identify a transcendent state, that any EEG patterns that are highly correlated with this state "would be an important bit of data." Although he suggests that "the empiric data is useful; it is not central," later he comments that to study mind, empiric-analytic studies "are of extremely limited and extremely secondary importance."

Wilber (1983) seems more concerned with the risks of discussing empirical data that is correlated to transcendent states than he is in considering how electronic and traditional techniques might be fruitfully blended. He states that using the "brain physiology" approach to collect EEG data from competent individuals in transcendent realms, "now constitutes one of the greatest obstacles to an acceptance of genuinely transpersonal states" because it would in some way blind us to the hidden "positivistic-reductionistic standards." Wilber seems very concerned about the acceptance of trans personal states by the wider scientific and academic community. We suggest that whether scientists with only an empirical perspective mayor may not come to accept transpersonal states, certainly should not affect our thinking regarding the possible fruitful blending of Western technology and traditional meditative techniques.

possible fruitful blending of Western technology and meditative techniques

We cannot know what the newly developing BEG biofeedback sophistication in conjunction with traditional techniques may allow us to experience or learn. So far, very important correspondences have been found to exist between BEG patterns and transcendent states. The technology has just matured so that very sophisticated real-time meditation-BEG biofeedback studies can now be conducted. People with talent in many areas need to work together in this enterprise including engineers, mathematicians, computer programmers, transpersonal psychologists, philosophers, statisticians, advanced teachers and students of the meditative traditions, and many others. Such people invariably bring with their talents, many perspectives, methods, and paradigms. How this diversity of talent and approach can be fruitfully blended will determine the results of such an enterprise. The development of the

current meditative traditions that Wilber (1983) so well presents are the result of the blending of many influences of many people over hundreds of years.

difficulty combining domains

3. The third impediment to the progress of EEG consciousness research is the difficulty facing research efforts that try to combine knowledge about both the empirical-physiological and spiritual domains.

It is the opinion of the authors that there are inherent strengths and limitations in approaching consciousness from either an empirical paradigm or from a paradigm based solely upon a view of ultimate states. Research in consciousness might benefit from the reliance upon a meta-paradigm that attempts to hold both of these perspectives in a state of co-existence.

At the heart of this challenge is the need to sustain a meaningful relationship between spirit and matter (mind and body), rather than polarizing these perspectives into opposites and splitting the opposites off from one another thereby eliminating from view the inherent relatedness of these two domains that is so clearly demonstrated by the research in psychophysiology. The containment of the relationship between spirit and matter, we feel, is inherently a more feminine approach which allows for the seasonal change of multiple views. The masculine approach is inherently more monotheistic and striving for the one and ultimate view.

issues of hierarchical ontology

Rothberg (1986) has addressed a similar concern in his recent critique of descriptions of the perennial philosophy. Rothberg has suggested that a central claim of the perennial philosophy is that of the hierarchical nature of the world and of the self. This "hierarchical ontology" he has suggested is at risk for being dangerously one-sided. He suggests that what is needed is

> an exploration of the corresponding, more "feminine" qualities: integration and relationship, awareness of the "ground," receptivity and openness, lind immanence, the "always already" quality of enlightenment and liberation (p. 26).

This same issue is central to the intellectual and practical challenge of approaching a study of EEG and consciousness from a multiple paradigm perspective. This is difficult for several reasons. It is uncomfortable to shift between paradigm perspectives. At worst, it may feel schizophrenic, as it requires containing a double or paradoxical view of what appears to be "one" thing. There is a strong desire to resolve contradiction, rather than to contain it. The challenge of shifting between a focus on physiology and a focus on a state of consciousness

requires a fluidity of theoretical perspective. The model that we are suggesting is to accept all levels of investigation as different parts or perspectives of the same reality, and to more fully appreciate the ways in which creative tension is generated by the juxtaposition of these various levels.

complementary aspects

It is our hope that the further development of EEG assisted meditation techniques and EEG consciousness studies may play some role in the emergence of a complementary feminine aspect to the masculine features of the perennial philosophy. This could result in the emergence of a more mature paradigm for the advancement of knowledge about consciousness that could encompass multiple levels of awareness, including the physiological and the spiritual.

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