Journal of Scientific Exploration, Vol. 11, No. 4, pp. 435–453, 1997 0892-33 10197

Topographic Brain Mapping of UFO Experiencers

NORMAN S. DON

Kairos Foundation and University of Illinois at Chicago,
1187 Wilmette Ave., #174, Wilmerre, IL 60091
norman.s.don@uic.edu

GILDA MOURA

Kairos Foundation, Caixa Postal 14528,
CEP 22412-000, Rio de Janeiro, Brazil
gilda.moura@unikey.com.br

Abstract — A cohort of Brazilian subjects, claiming experiences with UFOs involving contact or abduction, were selected for topographic brain mapping. One of the most important selection criteria was the ability to enter into a self-reported, non-ordinary state of consciousness or trance that developed spontaneously after their abduction or contact experiences. Analysis of their EEGs revealed that all subjects entered voluntarily into an hyperaroused trance. In this state, they maintained a condition of muscular relaxation and immobility while their EEGs exhibited high frequency (beta) activity at all 19 electrode sites, but with maximum activity at the prefrontal and adjacent loci. Inspection of the EEGs from the prefrontal/frontal sites revealed intermittent trains of rhythmic, approximately 40 Hz activity, attaining very high amplitudes, at times exceeding 40 microvolts. This activity was distinct in morphology and frequency from faster, usually concurrent activity, probably attributable to scalp muscle discharge (EMG). Analysis of 40 Hz, midline scalp activity, statistically controlling for the effects of EMG, revealed significantly more 40 Hz activity in trance than in baseline ($p < .006$). Also, the dominant alpha frequency increased during trance ($p < .01$). Both EEG findings suggest the occurrence of a state of hyperarousal. There was no evidence of epileptiform discharges in our data or clinical indications of possible epilepsy. Also, there was no brain activity suggestive of psychopathology, particularly schizophrenia, nor were there clinical indications of psychopathology. The EEG results were related to the physiological effects of highly focused attention and recent findings in neuroscience. Also noted were similarities to advanced meditative states and differences from psychopathology.

Keywords: UFO experiencers — hyperaroused trance — EEG — abduction Brazil — meditation — topographic brain mapping

I. Introduction

As part of a larger program of research into brain function and altered states of consciousness (ASC), the authors have recorded electroencephalograms (EEGs) and produced topographic brain maps for over 100 people in Brazil who engage in various types of trances, most of whom were not involved in the

UFO phenomenon. This particular study reports data from the subgroup that claims episodes of abduction by or contact with nonhuman (alien) beings from unidentified flying objects (UFOs). "Contact," or "close encounters of the third kind," involves the supposed meeting and interaction with alien beings, and is usually reported to be a beneficial experience. "Abduction," or "close encounters of the fourth kind," involves kidnapping, either in a conscious or unconscious state, and the performance of medical-like procedures on the abductee. The sequelae of these reported abductions usually involve significant psychological trauma.

In the preliminary phase of our investigations, which involved 10 UFO experiencers who were not in the final sample of 13, the data suggested that these subjects could voluntarily self-induce a state of hyperaroused trance, with high frequency, high amplitude brain waves, probably not attributable to scalp muscle artifact. For reports on the early phase of this work, please see Moura (1994a, p. 186-190; 1994b, p. 485-492) and Don (1994, p. 493-496).

We chose to investigate the UFO experiencers because they evidenced advanced stages of hyperaroused trance not found in Brazilian mystics and rare even among experienced yogi meditators from India.

The purpose of this study was to determine whether the frequency and amplitude characteristics (as evidenced in EEG recordings) of the subjects' brain function while in trance differed significantly from baseline, pre-trance measurements. Also, if such differences existed, we wanted to compare our results with EEG studies done on people who meditate. The veridicality of the subjects' experiences was not addressed.[1]

For an introduction to the literature on the abduction/contact phenomenon, see Moura (1996/1992), Mack (1994a), Sprinkle (1994), and Pritchard *et al.* (1994).

II. Background

The electrical activity of the brain, recorded from the scalp with surface electrodes, consists of waves with frequencies which range from approximately 0.1 cycles per second (Hertz or Hz) up to approximately 70 Hz for the normal adult (but possibly extending higher for selected subjects under unusual conditions). In most clinical EEG tests, only activity up to approximately 30 Hz is examined. The amplitude of these waves is in the range of 2 or 3 microvolts up to 100 microvolts.

Within these broad frequency bands, there are different frequency subgroups associated with differing states of arousal and brain function, each with

[1] Recently, experiments involving PET scans have shown that different parts of the brain are activated by true and false memories of recently spoken words (Schacter *et* al., 1996). Additionally, PET scans of survivors of trauma reveal a differential brain response under conditions of symptom provocation compared to control conditions (Rauch *et al.,* 1996). Therefore, beyond the issue of whether or not there is an altered state of brain function during the trances, it may in the future also be possible to examine whether or not brain function characteristics tend to support or disconfirm the veridicality of at least some components of abduction memories.

characteristic amplitude ranges in the normal adult. At the lowest end of the arousal continuum are "delta" waves, which range from approximately 0.1-3.5 Hz and are found during stage III and IV, normally dreamless sleep. "Theta" waves, approximately 4-7.5 Hz, are found most abundantly during transitions from the waking to sleep state (and vice-versa). "Alpha" waves (approximately 8-13 Hz) occur during relaxed, awake states, mostly with closed eyes, and are usually the highest-amplitude feature of the EEG record under these conditions. There is considerable individual variance in alpha wave amplitude; it is reported that 66% of subjects have 20-60 microvolts of activity, whereas 6% of subjects exceed 60 microvolts (Simonova *et al.,* 1967).

"Beta" rhythms are faster than 13 Hz, and usually predominate the EEG of the awake, alert, adult subject with open eyes, with amplitudes typically below 20 microvolts. The beta range can be subdivided into beta I (14-30 Hz) and beta II for rhythms above approximately 30 Hz; the latter are sometimes termed "gamma" rhythms.

A. Brain Function and High Frequency Brain Waves

In recent studies of brain function, mounting evidence supports the importance of high frequency brain oscillations above 30 Hz, especially in the 36-44 Hz frequency band.[2]

Animal studies with implanted electrodes, magnetoencephalographic and scalp recorded EEG studies with humans, and computer simulations, suggest that 40 Hz activity plays a central role in cognition and sensory processing (Sheer, 1984; Llinás & Pare, 1991; Llinás & Ribary, 1992, 1993; Steriade *et al.,* 1991, 1993). Further, the thalamic intralaminar nuclei, part of the thalamocortical circuits involved in the generation of 40 Hz activity, along with the midbrain reticular formation, have been shown in PET studies to be activated by attentional processes (Kinomura *et al.,* 1996). Highly focused attention is considered necessary in the generation of certain advanced meditative states, which we would therefore expect to be accompanied by broad band 40 Hz waves in the EEG.

Therefore, while it is well-known that beta waves are associated with states of alert wakefulness, recent work suggests that the higher-frequency beta rhythms are associated with heightened levels of brain function, or more broadly, consciousness.

B. Altered States of Consciousness

In the psychophysiological literature on meditation and ASCs, there are only four reports of beta wave (14 Hz or higher) increases during an ASC. Das

[2]Gray and Singer (1989) found power increases throughout the entire 30-46 Hz region of the frequency spectrum. In our analyses, the 30-50 Hz band was used, which we termed beta II. However, in the literature, these effects are usually reported as maximal in the 36-44 Hz band, which has come to be termed "40 Hz."

and Gastaut (1957) reported an EEG study conducted in India. Seven members of a spiritual community, practicing Kriya yoga, were measured in 20 recording sessions. However, Das and Gastaut reported only data from the "guru," the spiritual leader of the community, apparently because of his extraordinary ASC. He entered twice into a state of yogic ecstasy ("l'extase yogique") or "samadhi," during which he was physiologically hyperaroused, as indicated by the EEG and EKG, while the EMG recorded from the quadriceps remained flat (*cf.* Kugler, 1982). Among other findings, the subject's brain waves were reported to be 20-30 Hz and 40 Hz, generally distributed over both hemispheres, with amplitudes in the range of 30-50 microvolts.

This case study remains a landmark in the psychophysiological literature on meditation since it is the only one examining a very advanced subject in the state of yogic ecstasy or "samadhi," the culmination of meditation, which is considered to be the direct, conscious experience of the godhead (Eliade, 1958, p. 91-95). Since its publication some 40 years ago, even though it is just a single-case study, it apparently has not been challenged seriously. At that time, Henri Gastaut was widely considered to be the world's foremost epileptologist. It should be noted that Das and Gastaut used the terms yogic ecstasy and "samadhi" synonymously, whereas other sources, such as Fischer (1971) and Eliade (1964, p. 417), differentiate between ecstasy and "samadhi." Fischer, however, states that there is ultimately a joining of these two states at a certain, advanced point in the meditative process.

In a conference presentation in 1960 (cited in West, 1980), Fenwick reported three meditators practicing a mantra meditation (similar to the method of Transcendental Meditation). In the later stages of meditation, theta bursts were observed accompanied by beta activity.

The next study reporting high frequency brain activity (20 and 40 Hz) was by Banquet (1973). This cortical activity was found in four advanced Transcendental Meditation (TM) practitioners during the state of "transcendence," as defined in TM. The 20 Hz beta amplitude was very high (30-60 microvolts) while the 40 Hz activity was just a few microvolts. The high frequencies predominated in the anterior channels but were found sometimes in all eight channels recorded. However, since Banquet's studies, recent experiments have failed to replicate the presence of high frequency beta among TM meditators (F. T. Travis, personal communication, April 12, 1996).

The fourth and last study reporting fast beta waves during meditation was by Benson *et al.* (1990), who measured three Tibetan Buddhist monks in Sikkim while they practiced "g Turn-mo" yoga. They found that resting metabolism was raised voluntarily (a maximum of 61%) or lowered (a maximum of 64%). In one of the three subjects, EEG power in the 12-35 Hz band (a maximum frequency recorded) increased over 50%.

Additionally, Surwillo and Hobson (1978) found acceleration of the dominant alpha frequency with Christians during prayer and with a Moslem subject during Sufi meditation. Das and Gastaut also found this effect. This alpha ef-

fect is another indicator of hyperarousal. In contrast to this, forms of meditation promoting cortical quieting or hypoarousal, such as the earlier stages of TM, produce a slowing of the dominant alpha frequency and a state of consciousness different from practices promoting hyperarousal (Kugler, 1982; Fischer, 1971).

Therefore, while data from a very large number of meditators in hypoaroused states such as TM have been reported in the past 25 years (for a review see Jevning *et al.* (1992)), there are EEG reports of only a few subjects in an hyperaroused ASC.

However, hyperaroused altered states are well known to anthropologists from their study of some native peoples (Bateson & Meade, 1952; Deren, 1953; Rouch, 1960; Jorgensen, 1972). Experiences of very bright light are often associated with these trances and are a well-known characteristic of advanced meditative and mystical states (Eliade, 1964, p. 60-62). A common experience among our subjects when in trance was of a very strong light near the forehead. It therefore appears likely that this experience is another indicator of hyperaroused, non-ordinary states of consciousness.

Ring (1992) has reported the incidence of very bright, white light during the near-death experience. He has proposed that the "kundalini" syndrome, which is elucidated in tantric yoga (Eliade, 1958, p. 134), is the process common to both UFO and near-death experiences. Moura (199611992) has argued that while the "kundalini" process is involved in UFO experiences, it does not adequately account for all the reported phenomena. Das and Gastaut also related the hyperaroused ecstasy and "samadhi" of their yogic adept, or "guru," to the "kundalini" process of yoga.

Hence, although there have been many reports of behaviors or mental states suggestive of hyperaroused trance, there is a notable lack of advanced subjects capable of entering these states under laboratory conditions or controlled conditions in field settings.

III. Methods

A. Subject Selection

There were 5 males and 8 females who at the time of testing ranged in age from 19 to 72, with a mean age of 47.23 years. Their reported abduction or contact experiences occurred a minimum of two years before.

Criteria for selection in the study included:

1. Self-reports of UFO experiencers, including memories of contact or abduction by extra-terrestrial or nonhuman beings. All or part of the memories of the reported events were conscious, without the use of hypnosis.
2. The ability to enter voluntarily into a non-ordinary state of consciousness which reportedly commenced with the reported UFO experience.

All the subjects who agreed to participate in this experiment had received some form of psychological or spiritual counseling. As a result, there was amelioration of the psychological trauma, which enabled them to participate in the study. However, the subjects possessed varying tolerances for the hyper-aroused condition, some claiming that the intensity of the experience was sustainable for only a few minutes.

B. EEG Recording Procedure

The investigators traveled extensively in Brazil with a portable, 23-channel EEG and computer in order to gather the data. Recording sessions took place in a wide variety of field settings. Each session began with the recording of resting baselines with eyes open and closed. Following this, subjects were requested to enter their special state of consciousness.

C. EEG Equipment

The EEG was recorded using a Lexicor Medical Technology, Inc., Neurosearch-24 system. This equipment consisted of 19 AC-coupled amplifiers for EEG recording (low frequency cut-off at 0.5 Hz, time constant approximately 0.3 sec; high-frequency cut-off at 128 Hz with a 48 dB roll off/octave) plus five additional channels and related software for data editing and analysis. The sampling rate was 512/second for 10 subjects and 256/second for an additional 3 subjects. Electrodes were applied using an electrode cap and conducting gel made by Electro-Cap International, Inc. This consisted of an elastic skull cap with tin electrodes pre-positioned over the 19 International 10-20 scalp electrode sites with a forehead ground. Reference electrodes were applied to the left and right earlobes and linked. For most sessions, two additional electrodes were affixed to the center of the forehead, approximately one centimeter apart, for bipolar recording of frontalis EMG, or over the left masseter muscle. Over all testing sessions, the impedances at the scalp, ground and reference electrodes were usually kept below 3 k ohms.

D. Baselines

For all subjects, eyes-open and eyes-closed EEG baselines of 1 1/2 to 2 minutes duration were collected outside of trance while subjects were seated, relaxed, and in an upright position. For the last four subjects, eyes-closed control trials were also collected under instructions to tense the forehead musculature. This provided a control condition used in assessing and correcting for potential scalp muscle artifacts in the frontal EEG.

E. Trance

The recording period during trance ranged from a minimum of 1 1/2 to 2 minutes in duration in some subjects to as long as 10-15 minutes in others.

EEG analyses were restricted to the trance periods when subjects were relatively still with eyes closed.

IV. Results

A. Baselines

The baseline recordings of the cohort were typical of normal, resting EEGs, with no sign of abnormal brain function such as epileptiform patterns or slowing in the EEG; however, clinical challenges were not performed to assess for potential abnormalities.

The records showed the usual inter-subject variability of amplitude and varying amounts of alpha rhythms.

B. Trance

During the trance portion of the recording sessions, all subjects were able to enter trance voluntarily within a few minutes or sooner. At the commencement of trance, the EEGs changed to a generalized pattern of low voltage, fast activity which was sustained throughout the session. Further into the trance period, there was a gradual increase of frequency and amplitude of the brain waves at all 19 electrode sites. For most subjects, it was at the prefrontal (EEG recording sites Fp1 and Fp2), and for some subjects at adjacent frontal sites, that the trance EEG was most affected. However, for three subjects, the effects were distributed widely over the scalp.

Two features were salient:

1) Intermittent trains of rhythmic (sinusoid-like) brain waves, approximately 40 Hz activity, attaining as much as 40-50 microvolts amplitude. This was interpreted to be brain activity.
2) Faster, pervasive, approximately 80 Hz activity with some spiked morphology, up to 100 microvolts amplitude, probably attributable to frontalis muscle discharge.

Data from the control trials which simulated scalp muscle activation did not resemble data from the recordings made during trance conditions.

It therefore appears that both the 40 Hz brain activity and the very high amplitude 80 Hz discharge, probably due to scalp muscle activation, may both be indicators of a single, high-energy process affecting maximally the fronto-orbital regions, at the front of the brain.

*C. **Post**-Trance*

As the trance lightened, the fast activity gradually diminished; the subjects returned within a few minutes to the non-trance condition. The post-trance

recording resembled the baseline, and for some subjects showed evidence of a condition somewhat more hypoaroused than the original baseline.

D. Figures 1 and 2

Data from a representative subject are presented. Fast activity, due primarily to scalp muscle discharge, occurred most noticeably at the left temporal electrode site, **T3,** during pre-trance baseline and trance. Activation at the pre-frontal, supra-orbital sites, Fp1 and Fp2, occurred only in trance, and shows a mixture of 40 Hz, sinusoid-like brain rhythms, and faster, higher amplitude scalp muscle activity. Please see Figure 1.

In Figure 2, the EEG from pre-frontal sites, Fp1 and Fp2, are displayed for a

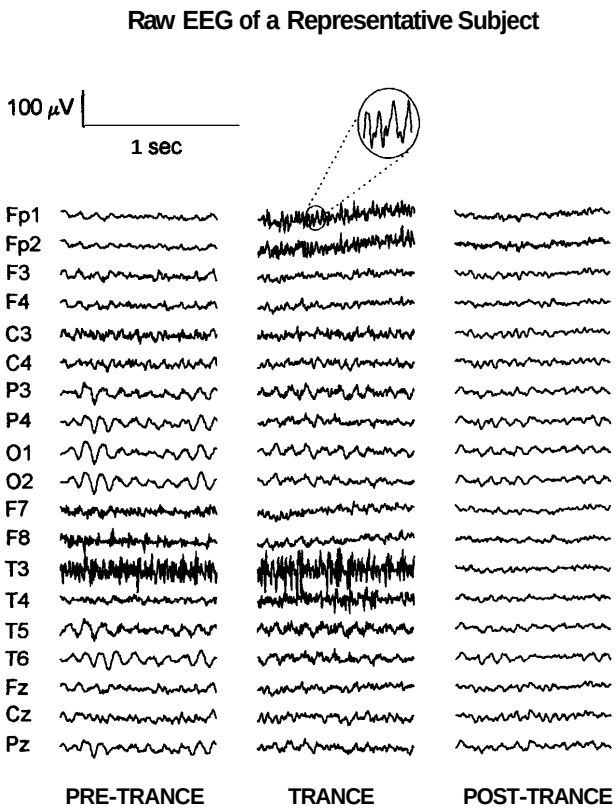

Fig. 1. Raw EEG tracings plotted at 30 mm/sec from a representative abductee during a pre-trance baseline (left column). Channel names are shown at far left. Scale bars for 100 μV amplitude and 1 second duration are provided at the top of the figure. A 0.1 second segment of channel Fp1, over the left pre-frontal scalp, during trance is zoomed (inset) to reveal a nearly sinosoidal rhythm of approximately 50 μV amplitude at 40 Hz. Scalp-recorded muscle artifact is usually irregular and arrhythmic.

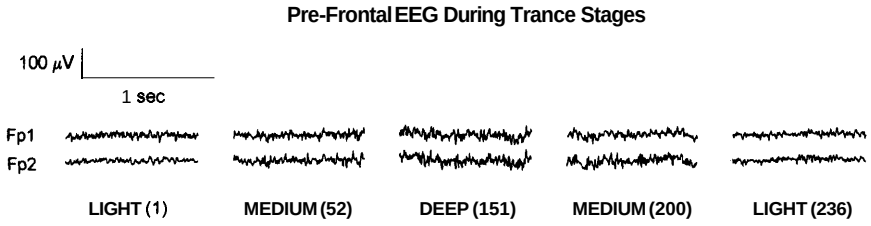

Fig. 2. Pre-frontal EEG of a second abductee showing the waxing and waning of brain activation during stages of trance. The number of seconds from commencement of the trance record are shown in parentheses.

second subject while in trance. Over the approximately four-minute duration of the trance, the progressive speed-up and slowing of the EEG is discernible.

V. Analysis of EEG Data

Raw EEG data were stored on the hard disk of a computer during sessions and later transferred to a 250-megabyte tape drive. Data editing and reduction were performed off-line. The data were recorded in sequential, one-half second samples or "epochs." All epochs of EEG data were inspected visually for eye movement and other artifacts. Epochs found containing such artifacts were excluded from further analyses. Power spectra were computed on artifact-free EEG epochs by a digital signal processing chip and associated hardware in the Lexicor NeuroSearch-24. For each of 19 channels, log power density in the theta (4-8 Hz), alpha (8-14 Hz), beta I(14-30 Hz), and beta II (30-50 Hz), and the 70-128 Hz frequency bands was computed.[3]

Because at higher frequencies (above 14 Hz and especially above 30 Hz) the EEG may also contain signals from scalp muscle discharge, it is necessary to control for EMG activity when computing the statistical effects of trance compared to baseline. See Appendix I for a discussion of the methodology used. The following statistical comparisons of baseline with trance were computed on data in which possible contamination by scalp muscle was controlled for.

Two statistically significant differences were found: The first for the midline electrodes (taken as a group) Fz, Cz, Pz, which are least susceptible to scalp

[3]Power density was computed by dividing the total power in each frequency band by the number of 2-Hz wide spectral lines comprising the band.

muscle contamination. In trance, there was more log power (0.13) in the 30-50 Hz frequency band than in baseline (0.04), $F(1/6) = 17.57$, $p = .006$. Secondly, in trance, the dominant alpha frequency (group maximum = 11.90 Hz) was faster than in baseline (group maximum = 10.85 Hz), $p = .018$, two-tailed, matched-sample, t-test. For a complete description of all statistical test results, see Appendix II.

VI. Clinical Neurological Assessment of EEGs

There was no evidence of organic brain syndromes among our subjects. In cases where there is organicity, one finds slowing of the EEG rhythms (Niedermeyer & Lopes da Silva, 1993).

It is well known that temporal lobe instabilities lead to disturbances of conscious experience (Fenwick, 1983; Fenwick et al., 1985). Persinger (1989a, 1989b) has hypothesized that some people with such labile brain function, especially when exposed to increases in geomagnetic radiation, will have unusual conscious experiences such as of nonhuman beings and UFOs.

A more likely explanation for these experiences in adults with no history of physical trauma to the brain is complex partial epileptic seizures. These most often occur in the temporal lobes, the limbic system, or are temperolimbic. The temporal lobes are associated with emotion and states of consciousness; ictally (during epileptic episodes), 4-7 Hz waveforms are found over the temporal lobes, and extending onto frontal regions. No such waves were found among our trance data. Fronto-orbital seizures also occur but are much less common.

During epileptic crises, there is typically a narrowing of the field of consciousness with delusions, hallucinations, and distortions in visual reality. Ictal experiences of ecstasy have been reported but are rare.

None of the thirteen people in this study has been diagnosed as epileptic and none was medicated. Because of their experiences, several had full diagnostic neurological evaluations prior to involvement in this study, which found no evidence of epilepsy. In an extended review of our physiological data and subjects' histories, our Brazilian epileptologist consultant concluded that they did not present any critical phenomena suggestive of epilepsy (H. Bello, personal communications, March - October, 1996). Additionally, unlike epileptic patients, our subjects voluntarily entered and left the state of altered brain function.

In order to obtain a second opinion regarding the possible presence of epileptiform EEG patterns during trance, we submitted samples of our data for examination by a senior-level, American neurologist specializing in the EEG and diagnosis of epilepsy. We were informed that there was no epileptiform activity present in those EEGs (J. R. Hughes, personal communication, June 24, 1996).

Both neurologists concluded that the rhythmic, approximately 40 Hz activity appeared to be cortical in origin. Additionally, our Brazilian consultant, Dr.

Bello, rendered an opinion that some of the above 40 Hz activity might be cortical in origin.

VII. Psychopathology of UFO Experiencers

A common reaction to reports of UFO experiences is that the claimants are somehow psychologically disturbed. While the UFO reports, taken at face value, seem to fall outside the range of possibilities of the Western world view, and sound delusional, hallucinatory, and even psychotic, careful psychological examination of UFO experiencers has failed to support the psychopathology hypothesis (Spanos et al., 1993; Mack, 1994a, 1994b). This was also true of the thirteen subjects studied here, all of whom were interviewed by a licensed clinical psychologist, who is one of the present investigators (GM).

Moreover, the EEG results observed for the present sample of UFO experiencers displayed a different pattern than is typically seen in depression or hysterical attack (Niedermeyer & Lopes da Silva, 1993, p. 345, 569-570). Most potentially relevant are the EEG findings from studies of schizophrenia.[5] Since the initial reports of Davis (1940), there have been numerous observations of increased fast beta activity in schizophrenic patients relative to controls which may sometimes have overlapped with the beta band studied here (For review, see Itil, 1977). However, the pattern of the EEG findings for our UFO experiencers is differentiated from the findings reported for schizophrenics. For the UFO experiencers, only the amount of fast beta activity was affected, whereas in schizophrenics, the amount of activity in lower frequency bands, including delta, theta, alpha, and low beta, may also be affected (Itil *et* al., 1972; Morstyn, et al., 1983; Gattaz et al., 1992). Further, the topographic distribution of the fast beta activity appeared to differentiate our UFO experiencers from schizophrenics, in that the beta activity was observed predominately over the frontal scalp in our subjects but was observed mostly at sites posterior to the frontal scalp in schizophrenics (*e.g.*, Morstyn et al., 1983; Gattaz et al., 1992).[5] Finally, our subjects could voluntarily commence and terminate the high frequency activity which was only present in the trance condition. Voluntary control of this activity is not found in schizophrenics.

VIII. Discussion

Brain activity of approximately 40 Hz, with 40 or more microvolts amplitude, was observed during the trances of all 13 of the UFO experiencers in this study. This unusual physiological condition has been reported only once

[4] Increases in fast beta activity may also be produced by ingestion of hallucinogenic drugs, such as LSD, mescaline or psilocybin; however, none of our subjects were using these substances at the time of testing. Furthermore, baseline was recorded a few minutes before trance and no high frequency activity was found there.

[5] Attempts to localize precisely the beta activity in many earlier studies of schizophrenia were limited by the small number of scalp sites recorded.

before, by Das and Gastaut (1957) in their case study of an East Indian adept in a very advanced state of meditation.

In common with or overlapping Das and Gastaut's results we found:

1) a statistically significant increase in power for 30-50 Hz, high amplitude brain waves, probably not due entirely to scalp muscle discharge;
2) a statistically significant increase of frequency in the dominant alpha frequency;
3) our subjects reported feelings of paralysis (reduced motor outflow) during their ASCs, suggesting inhibition of skeletal muscle tone;
4) although no formal challenges were presented, the subjects appeared to be unresponsive to normally distracting environmental disturbances;
5) states of unusual conscious experience.

Also, for most subjects, there was an easily observed increase in eye saccade frequency and amplitude, also indicative of hyperarousal (Fischer, 1971).

Since the recall of the reported experiences occurs in a non-ordinary state of consciousness, it seems likely that they are "state dependent." According to Rossi and Cheek (1988, p. 7): "It has been found that hormonal information substances released by the stress of any novel life situation can act as neuromodulators. These information substances can modulate the action of neural systems of the brain so as to encode memory and learning in a special manner." Therefore, it is likely that 40 Hz (and possibly higher frequency) brain activity was associated with the encoding of the reported experiences, as well as its recall. In order to re-experience contact/abduction, the state of brain function associated with the high-frequency rhythms must be reinstated.

Our results differ from Banquet's 1973 report on advanced TM meditators in their deepest stage of practice, in which high power 20 Hz activity was observed, while 40 Hz activity was present but much weaker. In our data, 20 Hz effects were absent while broad band 40 Hz effects were robust.

All our subjects were able to enter an extreme hyperaroused ASC, showing EEG similarities to the state reported by Das and Gastaut in their one advanced subject as yogic ecstasy or "samadhi." As we noted previously, although Das and Gastaut did not differentiate between these two states, they are usually not considered to be synonymous. We submit that our subjects were in an ecstatic state. Fischer (1971) assigns extreme hyperaroused trance to the ecstatic state. Also, the experience of "blissful excitement" (George, 1995, p. 82), a common characteristic of the ecstatic state, was reported by our subjects. They also related feeling that they were linked to a higher consciousness, and sometimes being connected with a non-human being or even with God.

Mack (1994a) and Moura (199611992) have reported on the ecstatic dimension of this class of subject. However, in contrast to the present study, although there are many accounts of the mystical experiences of yogis, there is no mention of abduction or UFO contact, suggesting that while there are com-

monalities between yogic states and the trance state of our subjects, there also are significant areas of difference.

The ability of the experiencers to enter trance developed after their reported contact with nonhuman beings and was not the fruit of years of intense practice of yoga or meditation. Whereas most of Das and Gastaut's seven Indian yogis had been practicing five to ten years, in 20 data-recording sessions with this group, only the spiritual head of the community attained the hyperaroused state, doing so on two occasions.

Almost all studies in the meditation literature involve hypoaroused states, such as are found in TM and Zen. These are characterized by the physiological slowing of a host of parameters (for a review see Jevning *et al.,* 1992) although Banquet (1973) reported the presence of fast beta predominantly at anterior scalp sites in more advanced TM meditators during the state they term "transcendence." However, as noted earlier, that beta has not been replicable in recent attempts. In contrast to the advanced TM meditators, our subjects did not exhibit increased beta I power, but did have a large increase of 40 Hz (and broad band 30-50 Hz beta II) power.

Also noted earlier, PET scans during focused attention by humans have revealed an activation of the midbrain reticular formation and the thalamic intralaminar nuclei (Kinomura *et al.,* 1996). Corollary to this finding, Llinás and Pare (1991) and Llinás and Ribary (1992, 1993) earlier proposed that the thalamic intralaminar nuclei, comprising the diffuse thalamic system, generates 40 Hz activity which integrates corticothalamic activity and so bears importantly on consciousness.

Also, earlier work by Sheer (1984, p. 64-84) found that scalp-recorded 40 Hz was associated with "focused arousal" and learning tasks. Q-sorts, investigating subjective aspects of different brain states, revealed differences between high and low frequency beta. The descriptors for the experience of 5-10 microvolt 40 Hz were: "attentive, concentrating, effortful, focused, investigating, searching, scrutinizing, studying, thinking, and vigilant." For low frequency beta (21-31 Hz), the descriptors were: "active, alert, anxious, energetic, excited, exhilarated, lively, restless, stimulated, and tense" (Bird *et al.,* 1978).

It therefore appears that as the focus of attention sharpens, the integrative activity of the diffuse thalamic system increases through the action of 40 Hz brain rhythms. Apparently, when attentional focusing becomes "laser-like," an extreme state of corticothalamic integration occurs and with it an amplification of normally unconscious brain activity.

At the extremes, either ecstasy or "samadhi," Fischer (1971) proposed that the constraints on normal, waking consciousness are bridged and a higher-order self or personality prevails which seems to transcend time and space.

While Das and Gastaut's "guru" had high-amplitude, very high frequency brain activity widely-spread over the scalp, the extreme activation pattern of our subjects was centered on the prefrontal and adjacent loci of the brain, but

in three subjects was more widely distributed. This suggests that for most of our subjects, the hyperaroused state was more circumscribed than for the "guru." In "samadhi," one is said to experience mystical unity with the Divine (Eliade, 1958, p. 91-95). While many of our subjects did report some degree of unitive experience, they all experienced a range of unusual phenomena that were not constrained by space and time in ordinary ways and appear to be unique to UFO experiencers.

The rarity of the extreme hyperaroused state of ecstasy is further supported by Bagchi and Wenger's study (1957) in which they recorded EEGs from 14 Indian yogis in a variety of settings, including caves. They found only changes in the alpha rhythms and no evidence of high amplitude fast waves. It is of importance to note that these advanced subjects did not report the experience of yogic ecstasy.

In contrast to this evidence, suggesting the rarity of ecstasy, all our subjects attained this physiologic state. They therefore constitute the largest cohort of subjects reported to this date exhibiting this apparently rare state of brain function. However, these results are correlational, and it awaits further investigation in order to establish a conclusive link between extreme, hyperaroused states of brain function and transcendental experiences.

VIII. Summary

Over a six-year period, we measured EEGs and produced topographic brain maps of over 100 people in Brazil who engage in various trances. Although it is true that there are many people engaged in mediumistic or other trance practices in that country, only the subjects who claimed contact or abduction experiences with UFOs — both in the preliminary and final phases of our investigations — presented evidence of advanced stages of hyperaroused trance. But in addition to involvement in "super-conscious" states, recent investigations in neuroscience have revealed the significance of high frequency brain rhythms in cognition, learning, attention, sensory processing, and as indicated by our results, state-dependent memory. However our subjects actually came by the ability to enter into their unusual ASC, it is important to point out that all our subjects could do so voluntarily, apparently without practicing for many years or initiation by yogic adepts.

Acknowledgements

We first wish to thank our research subjects who generously cooperated in this investigation. We also thank Hélio Bello, M.D., for the neurological consultations and the large amount of advice, encouragement and support he has given so graciously to the authors of this study. We wish to acknowledge Bruce E. McDonough, Ph.D., for his assistance with the analysis of the data. Additionally, the financial support of the Kairos Foundation is gratefully acknowledged.

Appendix I — EMG Correction

Controlling for Levels of EMG

The beta region of the frequency spectrum, especially above 30 Hz, is known to be particularly susceptible to scalp muscle contamination. Hence, comparisons of beta power between baseline and trance, known to differ in EMG levels, would be potentially biased. Ideally, all epochs containing potential EMG contamination would be excluded from analyses. However, because high amplitude activity over 30 Hz was apparent for most subjects throughout their trance periods, a simple data-exclusion criterion could not be employed. Therefore, in order to avoid potentially biasing the EEG comparisons between the baseline and trance conditions, an effort was made to balance the levels of EMG activity in these two conditions. EMG balancing between conditions was considered necessary only for analyses of beta activity. Analyses of theta and alpha activity were conducted on unbalanced data.

To control for EMG levels between conditions, EMG activity (defined operationally as total power in the 70-128 Hz region of the frequency spectrum) was calculated for each one-half second recording epoch. In accord with Davidson (1988; personal communications, 1994-1995), we assumed that any scalp recorded activity over 70 Hz was solely from muscle activity. However, there is no reported data on what the upper frequency limit for scalp recorded EEGs actually is, due only to brain activity. Especially with unusual subjects in an hyperaroused trance, the 70 Hz criterion may be arbitrary, and require revision in future research.

Because of limitations of our software, power in the EMG band could be computed only for the 10 subjects whose data were recorded at 512 samples/second. Separately, for each subject and electrode site, log EMG power for trance and baseline was compared by t-test. Trance epochs showing the highest EMG levels and/or baseline epochs showing the lowest EMG levels were then dropped and remaining epochs compared again; this process continuing iteratively until the log EMG levels were nonsignificantly different (t-test $p > .10$).[6] For 7 subjects, EMG levels between trance and baseline conditions could be brought into balance in this way at the midline sites Fz, Cz, and Pz. In general, midline sites, especially Cz and Pz, are least affected by scalp muscle discharge. Other scalp sites could also be balanced for some, but not all, of these subjects. Therefore, in order to maintain a sample size of at least 7 subjects, group analyses of beta activity considered only the 3 midline sites. That the EMG levels in the baseline and trance conditions did not differ for these 7 subjects after balancing was confirmed by 2-factor (condition x scalp site)

[6] "When data are correlated and cannot meet the assumption underlying the t-test that observations be independent, as is the case in the analysis of multiple EEG epochs from a single subject, the statistical significance of the result is likely to be inflated. Thus, the single subject t-test results may be regarded as conservative in the sense that they tend to overstate the extent to which the trance and baseline EMG levels differ for each subject.

Analysis of Variance (ANOVA), $F(1/6) = 0.03$, p = .874. Total log EMG power in the 70-128 Hz band was 1.24 for baseline and 1.23 for trance after balancing (averaged across 7 subjects and 3 scalp sites.) For the remaining 3 subjects, the distributions of EMG power in baseline and trance conditions were largely non-overlapping at all 19 sites, thus these data could not be balanced.

Appendix II — Statistical Analysis of Trance vs. Nontrance

Effects of Trance on Beta Activity

Log transforms were performed on power density data in the EEG bands for epochs remaining after EMG balancing. The log power density of single epochs was then averaged within subjects, separately for each channel and frequency band. Visual inspection of the data histograms suggested that the log power-density distributions were approximately normal. Questions of EEG power density differences between baseline and trance were examined in 2-factor ANOVAs with repeated measures across electrode site (Fz, Cz, Pz) and condition (baseline, trance). A separate 2-factor ANOVA was performed for each frequency band examined.

Marginal mean log power density in the 30-50 Hz beta II band was observed to be larger in trance (0.13) than during baseline (0.04), $F(1/6) = 17.57$, $p = .006$. A tendency for beta II to increase from posterior to anterior scalp was also observed, $F(2/12) = 3.26$, $p = .114$, $e = .5655$, with marginal mean log power density of 0.22, 0.08, and −0.04, at Fz, Cz, and Pz, respectively.[7] The condition by scalp-site interaction was nonsignificant, $F(2/12) = 0.33$, p = .724, $e = .5528$.

Marginal mean log power density in the 14-30 Hz beta I band was not different between trance (0.70) and baseline (0.69) conditions, $F(1/6) = 0.09$, $p = .780$. Neither the main effect of scalp site, $F(1/6) = 0.37$, p = .699, $e = .9598$, nor the condition by scalp-site interaction, $F(2/12) = 0.98$, $p = .404$, $e = .6361$, were significant for beta I.

Effects of Trance on Alpha and Theta Activity

Log power density in the alpha and theta bands was evaluated for all 13 subjects over the occipital scalp sites (O1 and O2) in separate 2-factor ANOVAs. It was possible to include all subjects since EMG infiltration into these lower regions of the frequency spectrum is likely to be minimal and, therefore, controlling for EMG levels was regarded as unnecessary. For analyses of alpha and theta activity, the power density of single epochs was averaged, within each subject and scalp site, before log transformation.

[7]Main effects and interactions involving the scalp-site factor were evaluated using the Greenhouse-Geisser adjustment where appropriate. Greenhouse-Geisser tail probabilities and epsilon factors (e) are listed in the text.

An ANOVA on log alpha power density, for all 13 subjects and 2 occipital scalp sites, indicated nonsignificant differences between baseline and trance, $F(1/12) = 0.26$, p = .621. The main effect of scalp site and the condition by scalp site interaction were nonsignificant as well. A separate ANOVA on log theta power over 13 subjects and 2 occipital scalp sites also failed to show differences between baseline and trance, $F(1/12) = 0.56$, $p = .470$. The main scalp site effect and the condition by scalp site interaction were also nonsignificant on log theta power density.

Effect of Trance on Dominant Alpha Frequency

We also examined our data for baseline to trance changes in the dominant alpha frequency, which were found in the hyperaroused states reported by Das and Gastaut (1957) and Surwillo and Hobson (1978). Six of the seven subjects analyzed above for beta I and II had well-developed alpha trains in baseline and trance. Their data from the left occipital site (01) were low-pass filtered at 14 Hz and the mean alpha frequency in baseline and in trance for each subject was determined with signal-processing software.

For all six subjects analyzed, the dominant alpha frequency increased in frequency from baseline to trance. The mean baseline alpha frequency was 10.06 Hz (range, 9.36 Hz - 10.85 Hz) and the mean trance frequency was 10.67 Hz (range, 9.70 Hz - 11.90 Hz); (Matched-sample t-test, t = 3.47, df = 5, p = .018, two-tailed).

References

Bagchi, B. K. & Wenger, M. A. (1957). Electrophysiological correlates of some yogi exercises. ***Electroencephalography and Clinical Neurophysiology,*** Supplement No. 7, 132.

Banquet, J. P. (1973). Spectral analysis of the EEG in meditation. ***Electroencephalography and Clinical Neurophysiology,*** 35, 143.

Bateson, G. & Meade, M. (Directors). (1952). ***Trance and Dance in Bali*** [Film]. New York: New York University.

Benson, H., Malhotra, M. S., Goldman, R. F., Jacobs, G. D., and Hopkins, P. J. (1990). Three case reports of the metabolic and electroencephalographic changes during advanced Buddhist meditation techniques. ***Behavioral Medicine,*** 90.

Bird, B. L., Newton, F. A., Sheer, D. E., and Ford, M. A. (1978). Biofeedback training of 40-Hz EEG in humans. ***Biofeedback and Self-Regulation,*** 3, 1.

Das, N. N., & Gastaut, H. (1957). Variations de l'activité électrique du cerveau, du coeur et des muscles squelettiques au cours de la méditation et de l'extase yogique. ***Electroencephalography and Clinical Neurophysiology,*** Supplement No. ***6,*** 211.

Davidson, R. J. (1988). EEG measures of cerebral asymmetry: conceptual and methodological issues. ***International Journal of Neuroscience,*** 39, 71.

Davis, P. A. (1940). Evaluation of the electroencephalograms of schizophrenic patients. ***American Journal of Psychiatry,*** 96, 851.

Deren, M. (1953). ***Divine Horsemen.*** London: MacPherson.

Don, N. S. (1994). Topographic brain maps of the abductee, Sueli. In **A.** Pritchard, D. E. Pritchard, J. E. Mack, P. Kasey, C. Yapp (Eds.), ***Alien Discussions: Proceedings of the Abduction Study Conference.*** Cambridge, MA: North Cambridge Press.

Eliade, M. (1958). ***Yoga: Immortality and Freedom.*** Princeton, NJ: Princeton University Press.

Eliade, M. (1964). ***Shamanism: Archaic Techniques of Ecstasy.*** Princeton, NJ: Princeton University Press.

Fenwick, P. (1983). Some aspects of the physiology of the mystical experience. In J. Nicholson and B. Foss (Eds.), ***Psychological Survey, No. 4.*** London: British Psychological Society.

Fenwick, P., Galliano, S., Coate, M. A., Rippere, V., and Brown, D. (1985). "Psychic sensitivity", mystical experience, head injury and brain pathology. ***British Journal of Medical Psychology,*** 58, 35.

Fischer, R. (1971). A cartography of the ecstatic and meditative states. ***Science,*** 174,4012, 897.

Gattaz, W. F., Mayer, S., Ziegler, P., Platz, M., and Gasser, T. (1992). Hypofrontality on topographic EEG in schizophrenia. ***European Archives of Psychiatry and Clinical Neuroscience,*** 241, 328.

George, L. (1995). ***Alternative Realities.*** New York: Facts on File, Inc.

Gray, C. M. and Singer, W. (1989). Stimulus-specific neuronal oscillations in orientation columns of cat visual cortex. ***Proceedings of the National Academy of Sciences,*** 90, 1698.

Itil, T. M. (1977). Qualitative and quantitative EEG findings in schizophrenia. ***Schizophrenia Bulletin,*** 3,61.

Itil, T. M., Saletu, B., and Davis, S. (1972). EEG findings in chronic schizophrenics based on digital computer period analysis and analog power spectra. ***Biological Psychiatry,*** 8, 321.

Jevning, R., Wallace, R. K., and Beidebach, M. (1992). The physiology of meditation: a review. A wakeful hypometabolic integrated response. ***Neuroscience and Biobehavioral Reviews,*** 16, 415.

Jorgensen, J. G. (1972). ***The Sundance Religion.*** Chicago: University of Chicago Press.

Kinomura, S., Larsson, J., Gulyás, B., and Roland, P. (1996). Activation by attention of the human reticular formation and thalamic intralaminar nuclei. ***Science,*** 271, 512.

Kugler, J. E. (1982). Meditation and the electroencephalogram. ***Electroencephalography and Clinical Neurophysiology,*** Supplement No. 35, 391.

Llinás, R. and Pare, D. (1991). Of dreaming and wakefulness. ***Neuroscience,*** 44, 3, 521.

Llinas, R., and Ribary, U. (1992). In E. Basar and T. Buttlock (Eds.), ***Induced Rhythms in the Brain.*** Boston: Birkhause.

Llinás, R., and Ribary, U. (1993). Coherent 40-Hz oscillation characterizes dream state in humans. ***Proceedings of the National Academy of Science,*** 90,2078.

Mack, J. E. (1994a). ***Abduction: Human Encounters with Aliens.*** New York: Scribners.

Mack, J. E. (1994b). Why the abduction phenomenon cannot be explained psychiatrically. In A. Pritchard, D. E. Pritchard, J. E. Mack, P. Kasey, C. Yapp (Eds.), ***Alien Discussions: Proceedings of the Abduction Study Conference.*** Cambridge, ***MA:*** North Cambridge Press.

Morstyn, R., Duffy, F. H., and McCarley, R. W. (1983). Altered topography of EEG spectral content in schizophrenia. ***Electroencephalography and Clinical Neurophysiology,*** 271.

Moura, G. (1994a). Abduction phenomena in Brazil. In A. Pritchard, D. E. Pritchard, J. E. Mack, P. Kasey, C. Yapp (Eds.), ***Alien Discussions: Proceedings of the Abduction Study Conference.*** Cambridge, ***MA:*** North Cambridge Press.

Moura, G. (1994b). A transpersonal approach to abduction therapy. In A. Pritchard, D. E. Pritchard, J. E. Mack, P. Kasey, C. Yapp (Eds.), ***Alien Discussions: Proceedings of the Abduction Study Conference.*** Cambridge, MA: North Cambridge Press.

Moura, G. (1996). Transformadores de Consciência: UFO — Contacto Alienigena. Second edition. Rio de Janeiro: Record (Nova Era). First edition 1992, Editora Atheneu Cultura.

Niedermeyer, E. & Lopes da Silva, F. (1993). ***Electroencephalography.*** Baltimore: Williams & Wilkins.

Persinger, M. A. (1989a). Increases in geomagnetic activity and the occurrence of bereavement hallucinations: evidence for melatin mediated microseizures in the temporal lobe? ***Neuroscience Letters,*** 88, 271.

Persinger, M. A. (1989b). ***Psi*** phenomena and temporal lobe activity: the geomagnetic factor. ***Research in Parapsychology 1988,*** 121.

Pritchard, A., Pritchard, D. E., Mack, J. E., Kasey, P., and Yapp, C. (Eds.)(1994). ***Alien Discussions: Proceedings of the Abduction Study Conference at MIT.*** Cambridge, MA: North Cambridge Press.

Rauch, S. L., van der Kolk, B. A., Fisler, R. E., and Alpert, N. M. (1996). A symptom provocation study of posttraumatic stress disorder using positron emission tomography and script-driven imagery. ***Archives of General Psychiatry,*** 53, 5, 380.

Ring, K. (1992). ***The Omega Project: Near-Death Experiences, UFO Encounters, and Mind at Large.*** New York: William Morrow.

Rossi, E. L. & Cheek, D. B. (1988). ***Mind-Body Therapy.*** New York: W. W. Norton.

Rouch, J. (1960). *La Religion et la Magie Songhay.* Paris: Presses Universitaires de France.

Schacter, D. L.,Reiman, E., Curran, T., Sheng Yun, L., Bandy, D.. McDermott, K. B., and Roediger III, H. L. (1996). Neuroanatomical correlates of veridical and illusory recognition memory: Evidence from positron emission tomography. *Neuron,* 17,267.

Sheer, D. E. (1984). Focused arousal, 40 Hz EEG, and dysfunction. In T. Elbert, B. Rockstroh, W. Lutzenberger (Eds.), *Functional Brain Imaging.* Berlin-Heidelberg-New York: Springer.

Simonova, O., Roth, B., and Stein, J. (1967). EEG studies of healthy population — normal rhythms of resting recording. *Acta Universitatis Carolinae Medica (Praha),* 13, 543. Cited in E. Niedermeyer & F. L. da Silva (Eds.) (1993). *Electroencephalography.* 3rd Ed., Baltimore: Williams & Wilkins, p. 132.

Spanos, N. P., Cross, P. A., Dickson, K., and Dubreuil, S. C. (1993). Close encounters: An examination of UFO experiencers. *Journal of Abnormal Psychology,* 102,624.

Sprinkle, R. L. (1994). UFO experiencers and a possible new experiential science. *Exceptional Human Experience,* 12, 2, 172.

Steriade, M., Dossi-Curro, R., and Oakson, G. (1991). Fast oscillations (20-40 Hz) in thalamocortical systems and their potentiation by mesopontine cholinergic nuclei in the cat. *Proceedings of the National Academy of Sciences,* 88,4396.

Steriade, M., McCormick, D. A., and Senjnowski, T. J. (1993). Thalamocortical oscillations in the sleeping and aroused brain. *Science,* 262,679.

Surwillo, W. W. & Hobson, D. P. (1978). Brain electrical activity during prayer. *Psychological Reports,* 43, 135.

West, M. A. (1980). Meditation and the EEG. *Psychological Medicine,* 10,369.