Sound and trance in a ritualistic setting visualised with EEG Brainmapping

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Abstract
In this article we analyse the results of two receptive trance-inducing methods (Body Monochord; Goodman Ritual Body Postures with fast rattling) that were compared between amplitude/significance mapping and rest. 28 EEG traces of two subjects (male/female) were obtained with a mobile brain imager during a group therapy ritual. Emphasis was put on an authentical group setting.
Both trance inductions caused an increase of Beta-II waves, the posture an additional Delta wave increase. While monochord playing induced frontal desynchronisation with increase of Beta-II waves in the male subject, the female EEG showed a synchronisation with changes ($p<0.001$) in visual and somato-sensoric regions. Her Alpha changes might indicate change of processing to a trophotropic trance state. Both showed increase of Beta-II waves indicating ergotropic trance. During rattling both subjects exhibited frontal-central increases of Delta waves. While female subject exhibited more pre-/frontal increases, male subject exhibited more parietal-occipital increases. Changes ($p<0.001$) on Beta ranges, spectral edge frequencies and Delta wave increases mark this state. Guttmann (1990) observed high and low frequency increases in the DC-EEG and called it "paradoxical arousal". Our results might support his observation.

Keywords: trance, EEG, brainmapping, sound, monochord, ritual body postures, pre/post design, ergotropic, trophotropic, altered states of consciousness, setting, group therapy.

1. Background

Work with trance-inducing sounds has become an intrinsic part of receptive music therapy in practice. At the beginning of the eighties, some experienced music therapists in Germany perceived a growing interest in the effects of music from outside Europe and started experimenting with trance-inducing effects of monochromatic sounds of monochord, gong, dijeridoo, sound bowls etc., developing individual empirical concepts (Bossinger & Hess, 1993; P. Hess & Rittner, 1996a; Oelmann, 1993; W Strobel, 1988; Wolfgang Strobel, 1994; Timmermann, 1983;, 1996). These first approaches were revised, further developed and also reviewed critically (Hartogh, 2001; Peter Hess, 1999; Jungaberle, 2003; Zeuch, 1999). Although the brain plays a decisive role in the experience of trance states, there is an astonishing lack of music therapy research into psychophysiological aspects of sound-induced trance.

We present an excerpt from an analysis of two trance inductions, i.e. one in recumbent position on a resounding body monochord (Rittner, 1997) and one "ritual body posture" according to Felicitas Goodman (1989; 1992) accompanied by fast rattling sounds. This study is part of the research project "sound and trance in a ritualistic setting visualised with EEG

brainmapping" at the Heidelberg university hospital in cooperation with the University Witten/Herdecke. This pilot study analysed four different methods of sound trance in a multi-perspective approach. The research design comprised visual and quantitative evaluations of a spontaneous EEG as well as psychometric measurements ("questionnaire on extraordinary states of consciousness" 5D-ABZ by Dittrich, Lamparter, & Maurer (2002) and "Phenomenology of Consciousness Inventory" PCI by Pekala (1991a; 1991b) and in addition a qualitative, content-analytical evaluation of written reports by participants on their experience. This paper presents the EEG evaluation of two induction methods; further results may be requested from the authors.

1.1 Body monochord

The body monochord is based on the design of the monochord invented about 15 years ago as a musical instrument for therapy purposes. It has the form of a double-walled wooden stretcher, with 26 strings of equal length and exactly the same tuning on the underside, so that a person lying on the instrument with eyes closed may perceive sound with the entire body, via skin, bones, vibration of body liquids, and auditory sense. Based on the keynote a, various "sound clouds" with overtones may be produced depending on the type of the music-making. We assume that readers are acquainted with this instrument.

1.2 Ritual body posture with rattle induction

Primarily, the method of "ritual body posture and ecstatic trance" ® is not so much a music therapy procedure but rather an approach from anthroposophical research providing access to altered states of alertness, where sound is used as an essential element of trance induction. An integration of this method into the clinical practice of music therapy and psychotherapy has turned out to be highly successful. A common factor of "ritual body postures" as they are called by the anthropologist Felicitas Goodman – they are up to 32.000 years old – is that as a rule they are perceived as a considerable effort and in combination with the sounds of a rattle or (frame drum) of approximately 210 bpm (beats per minute) produce a spontaneous burst of energy in the body; this burst of energy allows to induce in the subject a controllable hallucinatory experience on all levels of perception (vision, auditory sense etc.). The experience is imbedded in a well-tested, repetitive ritual. The procedure must be exercised so that a subject gets used to and feels safe with an almost unvarying ritual and is thus able to have a visionary experience. We call this a "controlled loss of control". The accompanying fast and even beat of a rattle has a stirring, although insufficiently researched effect on the central nervous system, due to rhythmic stimulation as well as the extremely high frequency of sound elements in the rattle noises. This combination is assumed to synchronize the naturally rhythmic physiological processes of all participants in the ritual.

1.3 Electroencephalogram

The electroencephalogram (EEG), discovered by Berger in 1929, has lost nothing of its fascination (Berger, 1991). Positrone emissions tomography (PET), functional magnet resonance tomography (fMRT) and other procedures produce highly soluble images of the living brain; but the EEG with its temporal exactness is an ideal instrument to measure electrical processes in the brain, and for music in particular. In addition, an EEG brainmapper provides something like a map of current intensities and wave speeds. Topographical presentations of main frequency ranges permit conclusions on functional interactions of brain regions and their levels of activity (Maurer, 1989). Slow and large high-amplitude waves (Delta and Theta) e.g. are predominant in sleep, while in states of high concentration and

alertness the waves tend to be quick with small amplitudes (Beta). Depending on vigilance and activity, there are various combinations of different waves. The alpha-frequency band (8-12 Hz), the waves of which emerge when closing one's eyes, acts as a mediator and indicator between the high and low frequencies of the EEG and the vigilant states between waking and sleeping (Basar, Schurmann, BasarEroglu, & Karakas, 1997; Schwendtner-Berlin et al., 1995).
The EEG is a physical indicator of physiological events. Both dimensions, the emotional experience and the pertinent alterations in the EEG, occur simultaneously and may be correlated to each other, but they do not permit a deterministic assumption of cause and effect. *"The problem is that the experience and its phenomenal and phenomenological, i.e. descriptive expressions are basically different perception modalities which exist besides each other and can never replace nor explain each other. The relation between the perception modalities exists only in their "simultaneity", i.e. their same temporal coordination"* (Machleidt, Gutjahr, & Mügge, 1989: 8). There is a fund of studies available in psychophysiology that may be used for comparison with the research question to come to a better understanding of the complex, psychophysiological interactions involved.

1.4 EEG and trance

No EEG analyses on trance experience on the body monochord were found so far. Studies on EEG and ritual body posture were published by Guttmann (1990). Available studies on trance and pertinent alterations in the EEG did not focus on music and trance but reviewed individual differences in trance experiences between a variety of mainly verbal trance inductions (De Benedittis & Sironi, 1985; Jaffe & Toon, 1980; Meszaros, Szabo, & Csako, 2002; Oohashi et al., 2002; Park, Yagyu, Saito, Kinoshita, & Hirai, 2002; Sabourin, Cutcomb, Crawford, & Pribram, 1990). It is interesting to note that more recent studies by Meszaros, Park and Oohashi come closer to the authentic situation, i.e. trance induction in situ, in their experimental design. In 2002, Oohashi succeeded for the first time in recording a naturalistic EEG of a trance during a ceremony in Bali (via EEG telemetry, specifically designed software and electrodes). At the height of the ceremony with loudly resounding bamboo instruments, a subject fell into trance (see Oohashi et al., 2002: 438). An analysis of the trance phase revealed a distinct increase in Theta and Alpha frequencies.
The question whether trance is a temporary state or a specific quality in persons addresses the state-trait discussion in psychology and has not been answered so far (see Meszaros et al., 2002: 500). Most studies assume differences in susceptibility to hypnosis, and subjects were psychometrically differentiated at the beginning. Sabourin e.g. compared 12 persons with high and 12 with low susceptibility to hypnosis respectively. At rest as well as under hynosis, persons with high susceptibility to hypnosis had higher Theta amplitudes compared to persons with low susceptibility (Sabourin et al., 1990).
The above-mentioned studies mainly showed alterations on the Theta, Alpha, and also on the Beta band.

The term "trance" (from lat. transire, change over to) has been defined in various, sometimes contradictory ways in literature (Meszaros et al., 2002; Pekala & Kumar, 2000; Rouget, 1985). We have used it here as a generic term for "various physical-mental alterations that may occur in persons at changed states of alertness independent of the cultural setting. Stimulus, techniques and ritual that induce and structure a trance depend on the socio-cultural context." (P. Hess & Rittner, 1996b: 395). An additional definition of trance by the ethnopsychologist Frigge is *"the disappearance of perception of the surrounding reality – due to psychological causes – under continued alertness"* (Frigge, 1994: 231). For the purpose of this study we assume that the state or personal ability to experience this state of consciousness may be induced and that the characteristica emerging in the EEG may be

differentiated. The degree to which test persons may be hynotised may be determined by a psychometric instrument (PCI von Pekala, 1991a;, 1991b). *"In musical psychotherapy with sound trance, music (...) is effective in two directions: 1. physiologially stirring (ergotropic) towards ecstasy by intensified rhythm in the field of perception (...) or 2. physically calming and internalizing (trophotropic) towards enstasis with reduced field of perception and focussing via monochromatic sounds"* (P. Hess & Rittner, 1996b: 401).
Ergotropic trance (ecstasis) in this context, in the sense of Fischer's mapping of altered states of alertness (R. Fischer, 1971;, 1976; Roland Fischer, 1998), means an alert, non-contemplative, wide-awake state of consicousness. Fischer says: *"The mapping follows along two continua: the perceptive-hallucinatory continuum of increasing central-nervous (ergotropic) excitement, and the perceptive-meditative continuum of increasing (trophotropic) damping."* (Roland Fischer, 1998: 48).*"Along the two continua, the sensory/motoric ratio increases. This means: the further you go along one continuum, the less will it be possible to verify the sensory element through random motoricity."* (the same, p. 51)
Accordingly, a trophotropic trance is characterized by a rather relaxed, contemplative, apparently sleepy state, and also by a rather inhibited movement profile, and reduced reaction and willingness to perform (enstasis).

2. Objectives
This study compares a presumably trophotropic induction (body monochord) with a presumably ergotropic induction (ritual body posture with rattling) in two test persons. The EEG was expected to show differences of a trophotropic state via EEG synchronization, i.e. via deceleration of the main frequencies and increase of slower wave ranges (Delta, Theta and lower Alpha frequencies of 8-10 Hz) (compare David, Berlin & Klement, 1983). Ergotropic states were expected to show in an EEG desynchronization and dominance of high-frequency waves (upper Alpha waves, 10-12 Hz, Beta-I, i.e. 12-Hz, and Beta II, 16-30 Hz).

1. Are there intra-individual alterations in the topographical spontaneous EEG compared to undisturbed rest?
2. Which inter-individual differences or common factors may be detected between the two test persons?
3. Does our study reveal an increase in Theta waves in persons highly susceptible to hypnosis?

3. Research methods
Topographical alterations of brain activities in two test persons were measured in a group setting with a topographical quantitative EEG brainmapping. Using pre/post designs, we compared artefact-free means of undisturbed rest (baseline state) with sound trance phases (altered state) induced by the body monochord or the ritual body posture with rattling.

3.1 Qualitative aspects of set and setting in this study
It is a well-known difficulty in physiological measurements that movements or activities in the course of a therapy may interfere with the precision of measurement data. EEG brain-mapping requires a limitation to receptive sound perception with little movement. Ideally, the test persons were to be recumbent or sitting still in order to avoid movement artefacts in measurement results. The NeuroScience BrainImager® used here was designed for EEG on intensive wards where reliable data collection is essential. Galvanic current separation and filter systems permit the recording of a solid EEG signal.
Measurements were taken in a therapy group setting (N=10). We attached specific importance to measurements being made in the ritual setting of a group well known to the test persons with the help of a mobile brain imager. Unlike an isolated laboratory situation, a group setting and familiarity with the experience will ensure that supportive sociophysiological factors

influence the sound-induced trance experience for all participants (naturalistic design).

Most attempts to locate practical music therapy in a laboratory setting impair the authenticity of the situation. The documentation of significant moments in therapy on recording appliances in particular demands a sensitive approach. In the realization of such a qualitative electrophysiology study (Jörg Fachner, 2004 in press) the measuring instruments must be adjusted as far as possible to every-day practice in order to generate explorative data. Consequently, we collect our data in the immediate therapy situation and not under lab conditions. On the basis of such explorative data collection, a test concept may be designed to review the tendencies revealed in exploration in a laboratory experiment under ideal technical conditions.

3.2 Test persons

For this pilot study we selected volunteers with trance experience who were acquainted with the induction methods. The intention was to ensure a high degree of familiarity with the ritual setting and as little sensitivity as possible to the research situation. We focus mainly on the results for two test persons out of ten participants in total (S. 1: Tom, S. 2: Angelika).

3.3 Study objective and study design

We examined a total of four different, tested, receptive music therapy procedures (compare figure 1), the trance-inducing effects of which on the participants were measured and compared:

1. body monochord; designed by H.P. Klein (see Rittner, 1997)
2. singing of monochromatic vocal sounds
3. Peruvian Whistling Vessels; oldperuvian whistles, trad. according to Statnekov (2003)
4. ritual body posture with rattle induction (according to Goodman, 1989;, 1992).

Figure 1: Trial design

After each of the four trance inductions, the test persons reported their experience in a written journal from which we quote. Two turns were performed, with an interval in between; one test person respectively was connected to the mobile brain imager in the group setting. Tom came first, then Angelika.

3.4 Technical details of the EEG

EEG impendancies of the 28 bipolarly (ear and ground electrode) generated EEG traces remain below 15 kohm.
Artefact control is achieved with a video protocol of the TP, the basic EEG data and the definition of a data-specific confidence interval of the respective brain maps. Details may be found in Fachner (2001) and Burgess & Gruzelier (1997). On the Delta band, which is sensitive to eye movements, all those maps were removed that showed Fp1 and Fp1 values in the frontopolar derivations within a dynamic range of above 150 μV.

Amplitude mapping

Every 2,5 seconds, the BrainImager calculates a mean image with amplitude values in colour shades from the 28 EEG sources via interpolation of the numeric sample data. The mean value images produced in this way were integrated with the statistics software of the NeuroScience BrainImager® to form one mean value image after artefact control (see above). The mean values of the amplitude mapping may be analysed visually via analysis of the topographical differences (F.H. Duffy, 1986); this method permits a differentiation between topographical reductions of amplitude values and frequency distributions of the frequency

ranges.

Significance mapping
The mean value images of the measurement stages may be compred to each other for significant differences with the t-test (F. H. Duffy, Bartels, & Burchfiel, 1981). The differences are presented in the form of a significance mapping. In significance mapping, colours do not represent the shades of amplitude and frequency, but the difference probability of both mean values. Here, the t-test compares the sampled (12 Bit, i.e. 4096 pts at 256 µV dynamic range) EEG waves of the respective mean value image with those coded numerically with the sample techniques of the BrainImager for deviations from the reference value. In the sense of a pre/post design, the undisturbed rest was chosed as reference value, and the respective trance phase was chosen for comparison. Further details on methods and techniques of the EEG brainmapping used here may be found in Fachner (2001; 2004 in press).

4. Results

4.1 Susceptibility to hypnosis

The PCI test that quantifies the occurrence of characteristic structures of altered states of consciousness via 12 main dimensions and 14 subscales is a method to determine retrospectively an individual's degree of hypnotic susceptibility (Pekala, 1991a;, 1991b). The hypnoidal score indicates in how far the experience of a situation resembles the experience of highly suggestible persons during hypnotic induction. The score for Tom on the integrated "Predicted Harvard Group Scale" (pHGS) shows him as "moderately hypnotizable" with 6,09, while Angelika may be termed "highly hypnotizable" with 7,78 points.

4.2 Body monochord

For the rest EEG and the subsequent sound EEG, the test persons were placed with their backs on the body monochord, with a cap on their head containing 28 electrodes, from which cables transferred the data to the brainmapping computer next door.

Figure 2: Test person with cap lying on the monochord

4.2.1 EEG alterations TP 1 (Tom)

Compared to rest, the monochord derivation for Tom showed a decrease of the frontal Delta waves and parietal Theta and Alpha and Beta II waves. However, the fast Beta-II frequencies (16-30Hz) showed an increase in the frontal regions.
Accordingly, the t-test comparison between rest and monochord revealed highly significant ($p<0.001$) differences on the Beta II frequency band from frontal to Gyrus praecentralis (compare figure 3).
The spectral band presenting the dominant peak frequencies and changes in frequency speeds showed an advancing desynchronization (increase of frequency speed) compared to rest. While Theta and low Alpha frequencies were observed in frontal regions at rest, the monochord phase was characterized by the onset of a desychnronization, with a dominance of medium and high Alpha frequencies. This change in frontal frequency speeds was highly significant (compare figure 3).

Figure 3: Significance mapping. T-test comparison of rest with body monochord for Tom. Perspective from above to the top of the head. The two-dimensional picture of frequency distribution shows the perspective from above. The upper curve corresponds to the nose, left and right to the oval forms the ears. The illustration shows the Delta band in the upper line left (0.3-4Hz), in the centre the Theta band (4-8Hz), to the right the Alpha band (8-12Hz)

lower line left Beta I (12-16Hz), in the centre (16-30Hz) and to the right the spectral band with the peak frequencies (above 87 % of relative frequencies). The number intervals represent the probability levels of changes from rest (reference) to monochord (comparison).

4.2.2 EEG changes TP 2 (Angelika)

In the case of Angelika, a decrease of Theta waves in temporal and frontal regions occurred compared to rest, while Alpha and Beta frequencies increased in parietal regions. In contrast to Tom, a synchronization to the front was recognizable in the spectral band during the monochord phase.
Changes were generally significant on the Alpha band, however not in frontal regions on the Theta band. Moreover, highly significant changes occurred in occipital regions on both Beta bands (compare figure 4).

Figure 4: Significance mapping. T-test comparison between rest and monochord for Angelika

4.3 Ritual body posture with rattle induction

The members of the group assumed a specific sitting body posture to which they were not accustomed; Goodman studied this posture entitled "olmecic prince" (Goodman, 1989: 158-161; Gore, 1999: 170-174). This posture was maintained for 15 minutes, accompanied by the rhythmic high-frequency sound of two calabash rattles.

Figure 5a: Archaeological artefact of the so-called "olmecic prince" (location of find Tabasco/Mexico, 1100-600 B.C (source: Gore, 1996, p. 170).

Figure 5b: Tom in the body posture of the "olmecic prince"

4.3.1 EEG changes TP 1 (Tom)

Figure 6 shows the amplitude mapping of the ritual body posture. With the exception of the amplitude increase on the Beta II and the Alpha band, the amplitude mapping for Tom shows an increase of Theta and Beta I as well as a left-hemispheric and occipital desynchronization in the spectral band (compare figure 6). The significance mapping for Tom also resembles that for Angelika.

Figure 6: Amplitude mapping. Mean value image of ritual body posture for Tom. The colours here show a shading of 2 µVof amplitude power. Dark colours represent less amplitude power, light colours more. The scale at the margin shows the relative frequency of the respective frequency share. On the right down we recognize the spectral band where the colours indicate shades of 2 Hz respectively. In the illustration of these peak frequencies, light colours signify high frequency speeds (e.g. orange = 24 Hz = Beta II) and dark colours stand for slow speeds (e.g. dark blue = 2 Hz = Delta). The spectral band gives the most distinct indications for desynchronization or synchronization processes.

4.3.1 EEG changes TP 2 (Angelika)

Compared to rest, the ritual body posture in Angelika combined with rattling reveals an increase of Theta waves from prefrontal and frontal and parietal-occipital along the vertex. Moreover, Alpha increases are to be found on the right, temporal-occipital and parietal. The Beta bands show distinct increases in parietal-occipital regions. The spectral band also represents a clearly visible increase in left-hemispheric frequency speeds (compare figure 7).

In significance mapping, the contrast to rest is represented in highly significant alterations on the spectral, Beta I + II and the Alpha band.

Figure 7: Amplitude mapping. Mean value image of ritual body posture for Angelika

5. Interpretation

The complexity of the topographic changes shown in the brain maps was the reason not to include a neuropsychological categorization and discussion of the functional significance of the regions "frontal", "parietal", "occipital", "temporal" etc. The focus of this article is on a descriptive presentation of results and a preliminary interpretion.
Both halves of the brain are divided into a frontal and a posterior half by the central fissure in the middle. The functions of the two frontal "quarters" may be generally be decribed as motoric, intentional, planning, and as the hypothetic effective location of the "self". The two posterior "quarters" have primarily sensory and receptive functions, are in charge of alertness-related processes and visual-spacial orientation. Even if this is a first orientation for the functionalities of a topographical description, the relations involved are far more complex. Details on functional correlations of brain regions may be followed up in the pertinent literature, e.g. by Kolb & Whishaw (1996).

5.1 EEG correlate of the monochord experience

Both test persons showed an increase in Beta waves and a decrease in Theta waves during the monochord phase.
Diminuitions in Theta waves, specifically in temporal regions (where primary auditory centres are located), while subjects were listening to music, were also found in a further study using this topographical EEG method. Fachner (2002) described this effect in a comparison of rest and music. Measurements with a direct-voltage EEG also revealed decreases in temporal regions (Altenmüller & Beisteiner, 1996; David, Finkenzeller, Kallert, & Keidel, 1969). Fachner found in his study with the NeuroScience BrainImager® that, in addition, the activity in the temporal regions is further dampened after consumption of a psychoactive substance (Cannabis). While the EEG signature of the substance was recognizable in synchronisation and Alpha-wave increase that characteristically influenced individual reactions to the music in EEG, this study appears to show that reaction to trance induction – in the case of the monochord in particular – is rather specific to the individual test person.
Despite growing physical relaxation, the desynchronozation and increase of high Beta frequencies compared to rest suggests an active visual imagination in the case of Tom *("A cloud rises in me and through the back of my head pulls me up to great heights ... I am flying, surrounded by clouds ... thousands of houses in green and lilac on a slope ... a beautiful sight...")*. The simultaneous decrease of Theta waves suggests increasing physical-mental alertness and an intentionally controlled imagination. The test person controls his own rather ecstatic experience.
In contrast, Angelika's EEG tends towards synchronization, induced by the Alpha increases. For her, the recumbent position on the monochord appears to promote a more relaxed and sensual body experience *(".. in me this turning movement .. as if I hovered in this rotation ... there were patches of haze or drifting veils and far away an unearthly music ... a feeling of calmness, of being sheltered...")*. She seems to "drift" into an enstatic experience, a contemplation and deep physical relaxation. This was most obvious in the t-test in the highly significant change of the Alpha frequency in the comparison of rest and trance. Accordingly, the trance phase EEG revealed an increase in Alpha waves. Crawford underlined the correlation between Theta activity, high suggestibility and a reaction of frontal and limbic regions. Function-related hippocampus and amygdala activities (in deeper layers of the central brain) suggest a complex pattern of facilitation and inhibition of neural interaction in the limbic system of persons highly suggestible to hypnosis (in Sabourin et al., 1990). Since our two subjects turned out to differ in their suggestibility to hypnosis as a test result, i.e. revealed

differences in facilitation and inhibition, this seems to influence the experience regarding tendencies towards ecstatic or enstatic experience. For Angelika, the hypnoidal score of the pHGS indicated "highly hypnotizable" (see above); she reacts more in the sense of a trophotropic trance with increasing low-frequency waves, while Tom reacts in the sense of an ergotrophic trance with increasing high-frequency waves.
Our study reflects the effects of the monochord on both test persons in similar, subjective descriptions of hovering states, visions of cloud-like forms and changes in the body feeling. *"My impression is that I drift through space lying on the monochord" is Tom's description.* Angelika: *"They were very slow, but even movements … as if I hovered in this rotating movement … a tremendous space in grey and white, through which veils were drifting".*

5.2 EEG correlates of ritual body posture with rattling

5.2.1 Reports on experience

How to describe the experience of a "ritual body posture with rattle induction"? Exemplary excerpts from written reports by Tom and Angelika serve as illustrations. Angelika saw and perceived herself as a "vulcano" in trance:

> *I see the streams of lava in orange-red seeping over the black earth. It is still happening extremely slowly but evenly. Then I can feel a large opening in my lower abdomen through which lava comes out of me, too. I see it seeping out of me, can feel it in a very sensual way, and at the same time I am lava myself. After a long interval I hear the rattles again. They sound like thundering stones. My hands become rocks, which I throw away. Rocks keep growing, and I keep hurtling them away. I still am the vulcano. All this does not feel very alarming but powerful. Then the movements of hurtling stones and of streaming lava cease. I feel light emerging in front of me. Everything is perfectly still, I am immobile, too. I can see tiny green plants sprouting from my hands, can feel them coming out between my fingers. – I feel full of power and content."* (Further details in: (Rittner, im Druck).)

Tom identifies with the archaeological artefact of the "olmecic prince":

> *"As soon as the rattling starts, I start to drift. I see figures and objects in front of me. An altar made of stone, in the middle of jungle. The images are more what I feel than what I see. Something bright and yellow on the altar .. the brightness becomes a crown, like the head dress of the "olmecic prince". The crown becomes larger and brighter. I see the very tall olmecic figur sitting in front of the altar. Creepers climb up all over it … the whole place is … grown over with plants. A tall, upright serpent … looks at me, in the foreground. This is a very powerfull, "knowing" place … I see the earth as a rotating globe in green and blue. I watch it for some time and then I think: "and this is why the earth moves!" – The rattling stops, far too soon, a pity. I feel "dazed" for a long time. I feel I have taken in a lot of knowledge… the key to essential questions…"*

Experience gained in altered states of consciousness becomes apparent e.g. in changes in thinking, emotionality, perception of meaning and a feeling of something unutterable (Ludwig, 1966). A known effect is improved memory of what has been perceived during the ritual body posure. The increase in Theta waves and highly significant changes on fast frequency bands observed in Angelika, in visual regions specifically, may represent a more active access to image-like structures, analogous to a dream experience. The images and insights perceived or remembered in trance through spontaneous emotional intuition ("*I still am the vulcano. All this does not feel very alarming but powerful…*") are possibly reflected

here in the increase of Theta waves in the limbic system and of Beta waves in visual regions.

In 1990, Guttmann was the first to demonstrate in studies with the direct-voltage EEG that in the ritual body posture with rattle induction and simultaneously with the occurrence of Theta waves in the EEG, there was an unusual increase of cortical negativation (DC potential) of 2000-3000 microvolt (Giselher Guttmann, 1990: 319). This indicates an overactive state of the cerebral cortex and in spontaneous EEG would be evident in a dominance of Beta waves. Guttmann coined the term "paradoxical arousal" or "relaxed high tension" for this phenomenon.
Park et al. (2002) found changes in the EEG in the case of a Salpuri dancer in comparing rest, listening to music and memory (of a previous dance). Salpuri is a traditional dance performed by medicine men in Korea. In the phase of remembering an ecstatic trance state in the dance, frontal increases of low alpha frequencies (8-10Hz) were found as well as frontal-occipital Theta increases, compared to rest. In the comparison of rest and listening to a piece of pop music, there was a highly significant increase in the frequency of high Alpha frequencies (10-12.5 Hz) over the entire cortex. This may have indicated a difference between a primarily physical trance experience and the enjoyment felt in listening to music. 9.5 Hz was the identified peak frequency in rest and memory of dance, with an increase of amplitude energy in the memory of dance. The peak frequency rose to 10 Hz in the process of listening to music, and high Beta frequencies increased. Park supposes that the Salpuri dancer *"reaches the altered state of ecstatic trance through suppression of frontal cortex functions and activation of subcortical functions"* (Park et al., 2002: 961), i.e. that trance is characterized by Theta frequencies, the dominance of which in the EEG suggests such an activation.

5.3 Beta changes

The increase in high Beta frequencies while a subject listened to music reported by Park are also known from other studies on music perception. Walker (1977) reported increased right-lateral activity while listening to classical music; Behne et al (1988) reported occipital increases; Petsche (1993) found increases in posterior right-lateral coherence, and Bruggenwerth reported music-related, emotion-specific decreases or increases of posterior Beta activity (Bruggenwerth, Gutjahr, Kulka, & Machleidt, 1994). According to Petsche (1994), the Beta frequency bands indicate differentiations of music-related cognitive activity. The conspicuous reaction of the EEG in both trance inductions with an increase of high Beta waves (16-30Hz) seems to be a further indication of the influence of trance triggered by sounds. Isotani et al. (2001) explored hypnosis-induced states of relaxation and anxiety and discussed the conspicuous reactions with high Beta frequencies and their EEG signature in emotional states.
Meszaros et al. (2002) interpreted the EEG for hemispheric differences and described a primarily right-hemispheric, parieto-temporal EEG reaction of the Alpha and Beta band in persons highly susceptible to hypnosis; he concluded that in the "*mainly emotion-focussed hynotherapies*" (the same, p. 511), as expected, right-hemispheric changes will be dominant. In his study, persons with high, medium and low susceptibility to hypnosis all experienced an altered state of consciousness while listening to music in a relaxed position in an easy chair. Significant differences in the "Altered State Index" were only found for the areas imagination/ hallucination (compare the same, p. 510).
Consequently, the Beta changes we found for the monochord as well as for the ritual body posture seem to illustrate the emotional reactions produced by the ritual and the sounds, which in the case of Tom resulted in an anterior right-hemispheric, and for Angelika in a posterior left-hemispheric change.

6. Conclusions

Returning to the research questions stated at the beginning, we found and described inter- and intra individual differences in comparing rest and trance induction. In this study with two test persons, highly significant differences were found in the topographical EEG comparing rest and trance. The profile becomes irregular in the case of the monochord. The female subject recumbent on the monochord showed a more trophotropic trance, indicated by an increase in Alpha waves, while the male subject showed a desynchronization and an increase of Beta waves, which suggests a more ergotropic trance. The data available do not explain whether these findings suggest gender-specific or mood-dependent differences, or differences in susceptibility to hypnosis.

Moreover, the topographical EEG showed a distinct difference between rest and sound-induced activations. The temporal regions of both test persons revealed a decrease on the Theta band.

Both subjects, however, showed similar reactions in trance induction through ritual body posture accompanied by rattling sounds. In both cases, there was a simultaneous increase in low and high frequency waves of the Theta and the Beta band. This state, described by Guttmann as *paradoxical arousal*, appears to be a specific reaction to this method of trance induction rediscovered by Goodman. We confirmed for a ritual group setting what Guttmann et al. discovered in laboratory tests as early as 1990: an ecstatic trance induced by sound and body posture is characterized by a “relaxed high tension”.

A possible answer to our question concerning Theta increases in easily hypnotizable persons was only visible in body posture; but in the monochord test we also found a tendency toward synchronization and increased low frequencies in the easily hypnotizable subject. Increases in Theta and Alpha waves during the trance phase reported by other authors were most pronounced in the ritual body posture.

These results represent only a very small part of the entire data evaluated and are of an explorative nature. The last measurement phase (compare figure 1) covers, as expected, influences of the three previous trance inductions via singing, monochord, and listening to and playing of old peruvian whistles. An ergotropic trance may well be characterized by an increase in high-frequency waves, and a trophotropic trance by an increase of low-frequency waves. The ritual body posture with rattles seems to cover both forms of reactions.

Contrary to the concern of suffering loss of control in altered states of consciousness, our repeated findings of high Beta II elements illustrate that self-control is maintained in these methods of sound-induced trance and may even give way to a highly concentrated hyper alertness in the sense of an ergotropic trance. This is confirmed by the participating test persons as well as by our test results. A welcome effect of our study would be to reduce the fears deeply rooted in our society for cultural, historical and political reasons that trance is equivalent to loss of control and susceptibility to manipulation.

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