EEG-Brainmapping during changed Music Perception induced by Tetra-Hydro-Cannabinol

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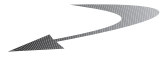


Abstract

Presented here is a single case study conducted in a qualitative and quantitative way. Great importance was attached to realise a setting close to the user's normal, private situation in everyday life, because the atmosphere of a laboratory will effect the quality of the experienced contents of consciousness.

EEG-Brainmapping was performed during listening with closed eyes to three different pieces of music in habituated setting. The music was heard before and after smoking Cannabis (Ì 20 mg Δ^9 THC). Data were averaged and treated with a T-test and a phenomenological schedule.

Differences (P>0.01) appeared in the right hemisphere, along the motor cortex on beta(β)-I, theta(ϑ)-, and on alpha(α)-frequencies in the right frontal Cortex. This could be effects of the cerebral blood flow changes.

A common finding in all averages of the altered state was a low intensity of brain activity on delta-, theta- and beta I+II-frequencies. On the alpha frequencies we found a strong activity peak in the parietal-occipital left, the so-called `analytic and receptive´ hemisphere around the EEG measuring point P3. This cortical area is known as a

part of the auditory and visual association areas. The alpha-Peak in connection to the reciprocal relation of low brain-activity and the subjective reported state of `being high´ could be a neurophysiological basis for the reported experiences of cannabis users with synaesthetic effects, like `seeing colours and shapes related to the listened music´ and similar psychological characteristics found in some studies about altered state of consciousness. Moreover it could be a special physiological function of the recently discovered C-br-receptor and the anandamid related to music.

Aim of the study

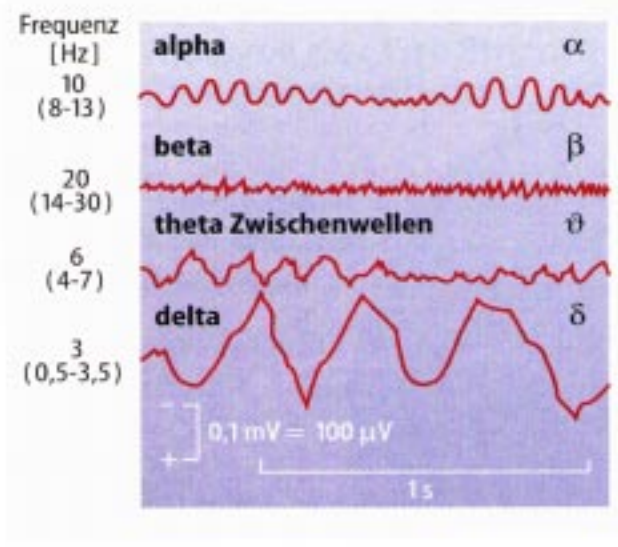
As you can find out in the scientific literature cannabis induces temporarily an increased sensibility of the perception- and movement systems, of emotion, a changed sense of time estimation and increased association patterns (Murphy & Bartke 1992; Solomon 1966; Stefanis, Dornbush & Fink 1977; Szara & Braude 1976; Tart 1971), but what happens in the brain while experiencing with music and cannabis? What is happening in the brain, with an EEG-Cap on, in a relaxed private setting during music perception under the influence of Delta-9-Tetra-hydro-cannabinol? What are the differences in the EEG by listening to the same pieces of music during the baseline state? What do they mean and in which way are they reflecting results of inquiry and experiences of artists and users?

In order to get an answer to this questions I had the opportunity to investigate an EEG-Brainmapping study during listening to music in a relaxed setting. This brain imaging method measures the different brain frequencies on their intensity and locality. The first goal in the design of the study was a comparison of the quantified results before/after smoking a Joint with about 0.3 grams of Nepalese hash (Ì 20 mg THC) and listening to music.

Method

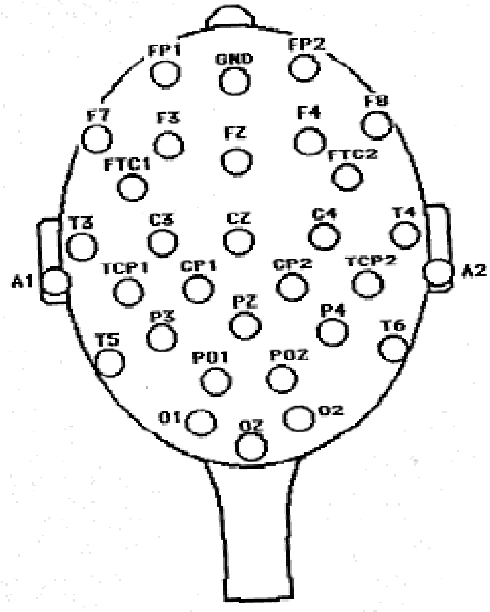
EEG-Brainmapping

ABBILDUNG 1. WaveForms of EEG-Trace



The EEG-trace is linked to physiological time processes. Activity states of the brain are represented in the different frequency forms.

ABBILDUNG 2. Electrode positions of the EEG-Brainmapper



Here, with the NeuroScience BrainImager a *map of brain activities* can be produced. All 2.5 seconds the entire information of the *28 electrode-traces* is joined (Interpolation) to spatial amplitude/%- maps representing different frequency ranges (delta; theta; alpha; beta), absolute and relative power and spectral shifts of the centre frequencies. *Centres of strong EEG-activity* are presented on-screen through lighter colours; the areas of weaker EEG-activity are presented through darker colours.

Experimental Schedule

Baseline State (Listening to music without THC-Exposure)
∑ listening to 3 pieces of music with closed eyes
∑ 1 minute silence between the 3 songs

30 minutes intermission

Smoking: 0.3 gr. black Nepalese in a Joint with ca 20-mg THC

After 10 Minutes start

Altered State (Music listening with THC)
Listening to the same songs / same measuring situation and setting/ person as his own control

Subject listened to his favourite Music

1.) King Krimson - *"Prelude/Song of the Seagulls"* on LP "Islands"

2.) Dogbowl - *"Obsessed With Girls" on "Tit! (An Opera)"* Shimmy Disc 1989

3.) King Missile - *"We can work it out" LIVE* at Knitting Factory

Results

(Sorry, the whole Discription of the first findings and the technical issues are not translated yet and not included in this article. They are published in *Curare, Journal of Ethnomedicine, 1995, 18,(2) 331-358*)

1.) Averages over the first piece of Music

(Note: The pictures show the brain surface from a position above the head, as if you are looking *on* the brain; the nose is on the superior side)

ABBILDUNG 3. Baseline State: EEG Brainmapping average for listening to "Prelude" from KING CRIMSON without Cannabis

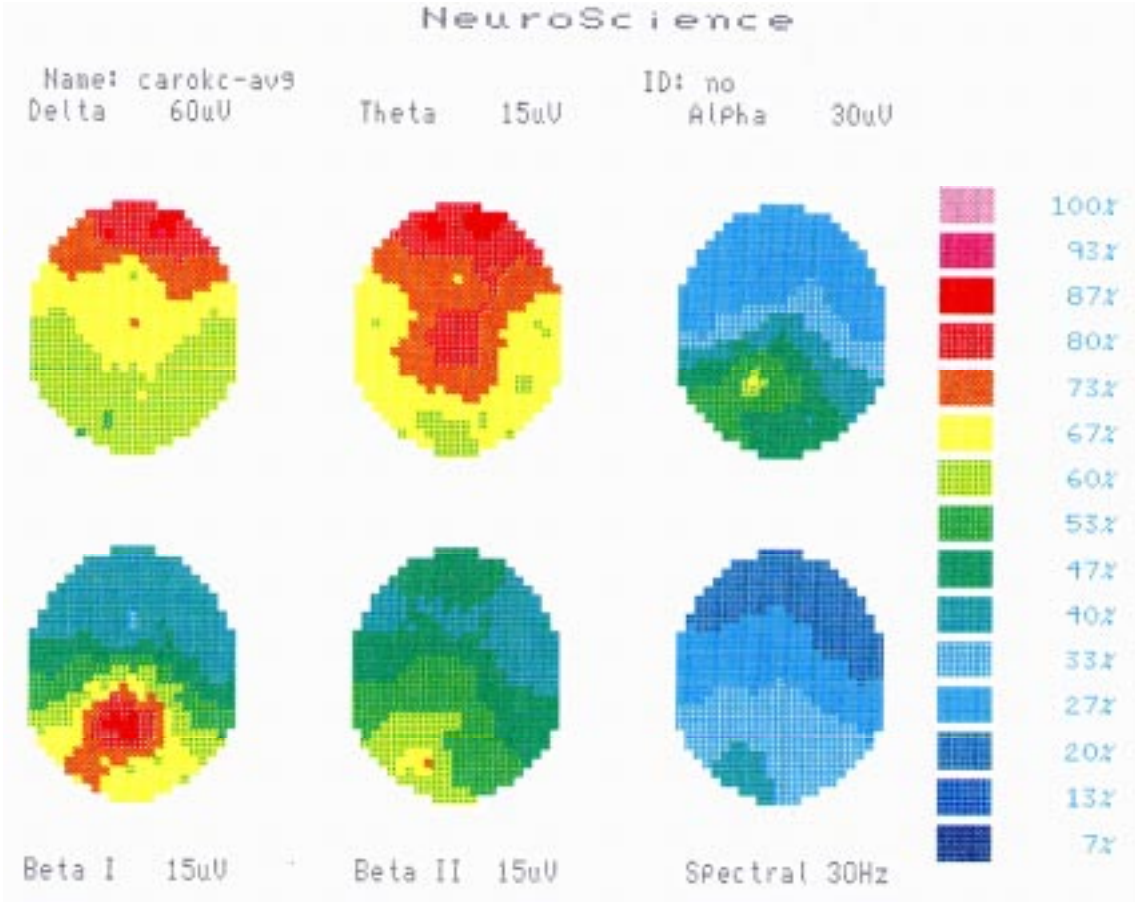
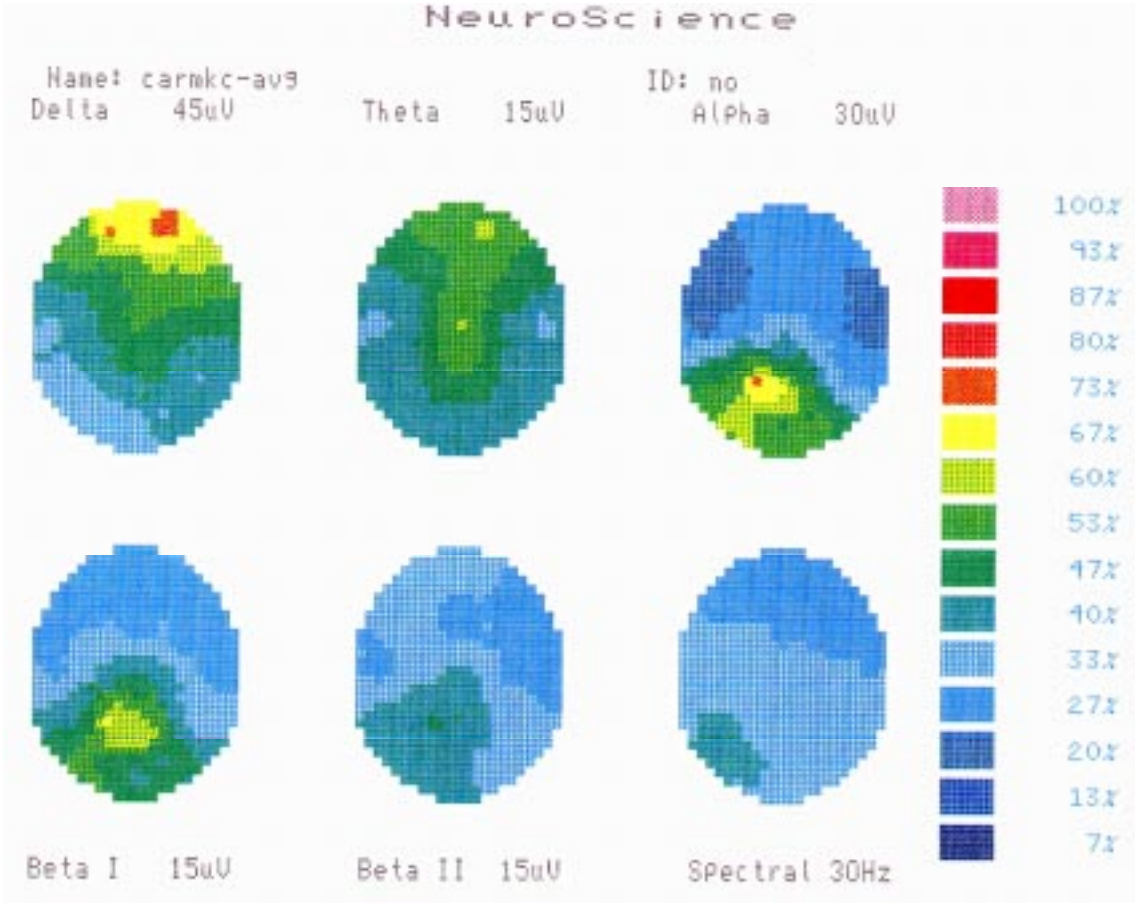


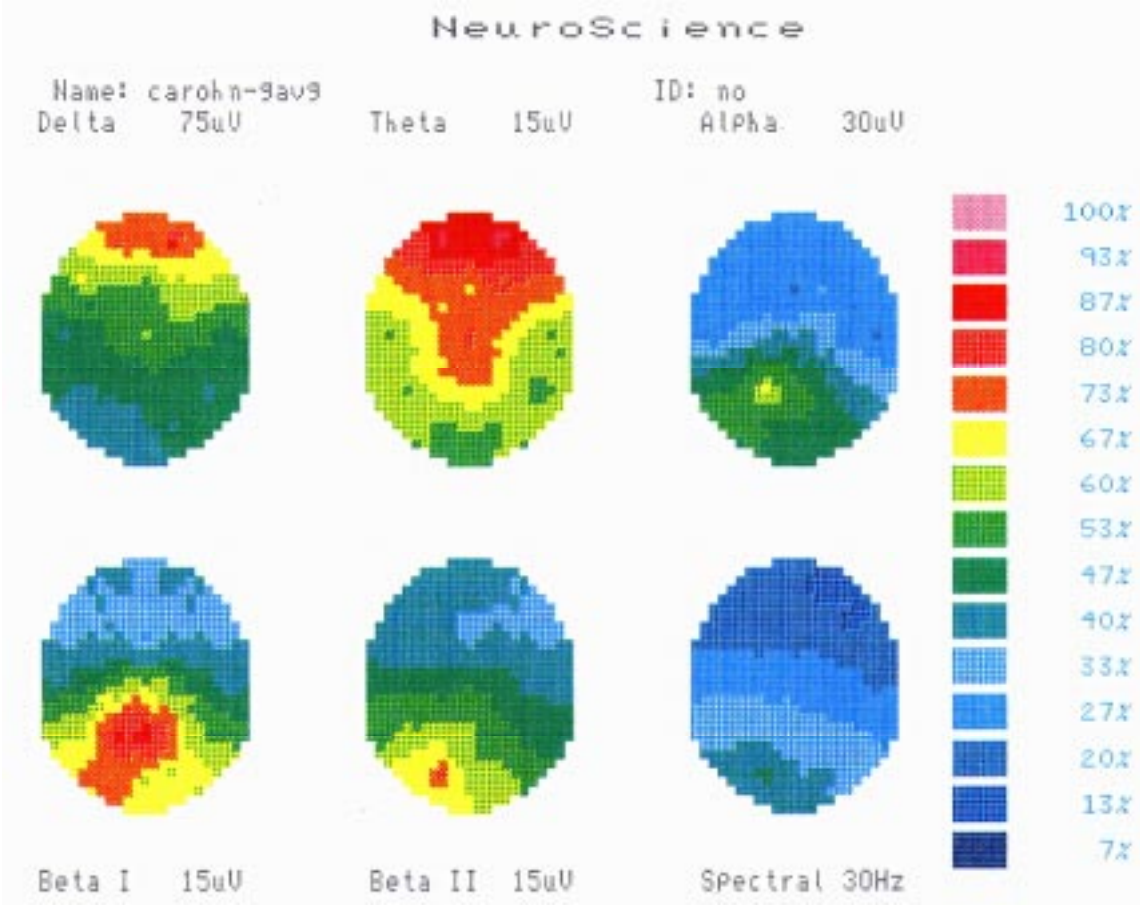
ABBILDUNG 4. Altered State; EEG Brainmapping average for listening to KING CRIMSON with Cannabis



There was a significant change (T-Test, p>.001) in brain activity on theta, beta and delta frequencies after smoking the Joint and listening to the first piece of music.

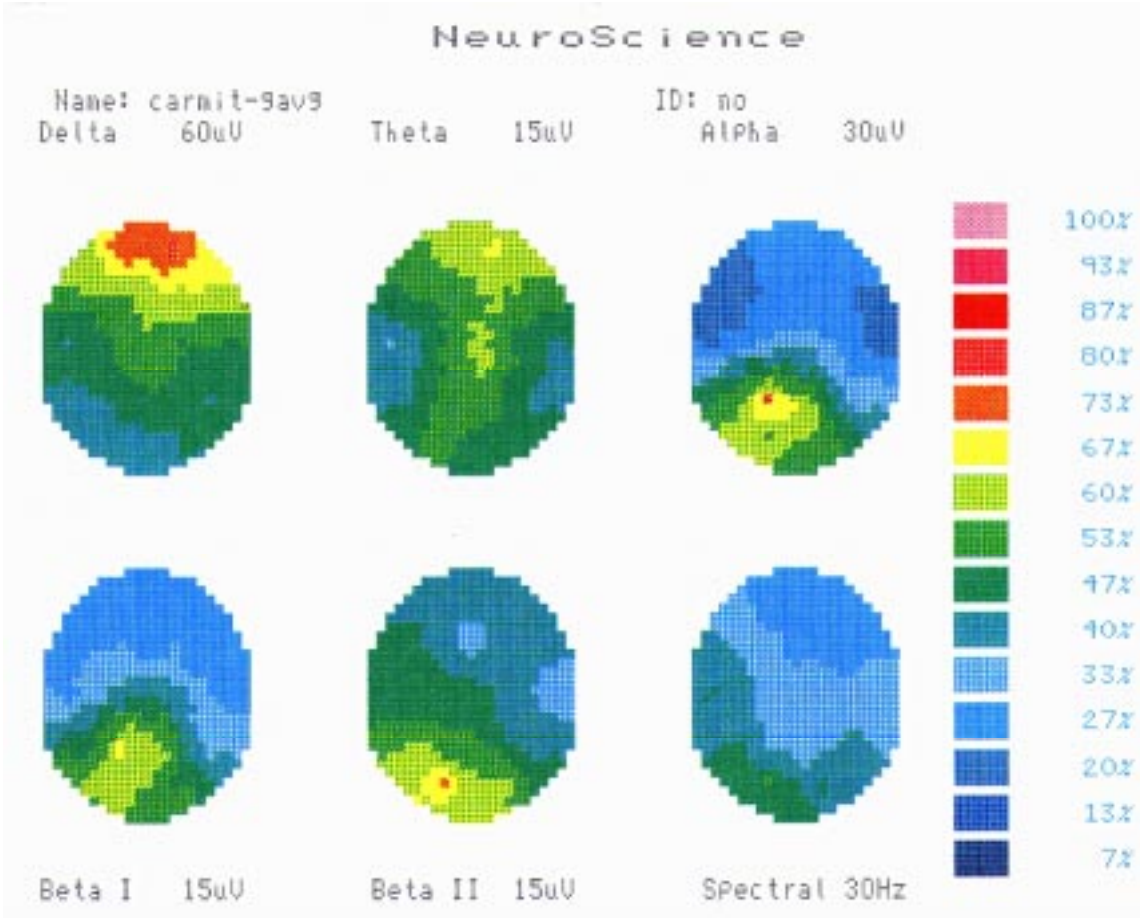
2.) Group averages for listening to three pieces of music during baseline state to altered state

ABBILDUNG 5. **Baseline State; EEG Brainmapping group average during listening to three pieces of Music <u>without Cannabis</u>**



EEG Movie pre ?!

ABBILDUNG 6. Altered State: EEG Brainmapping group average during listening to three pieces of music with Cannabis

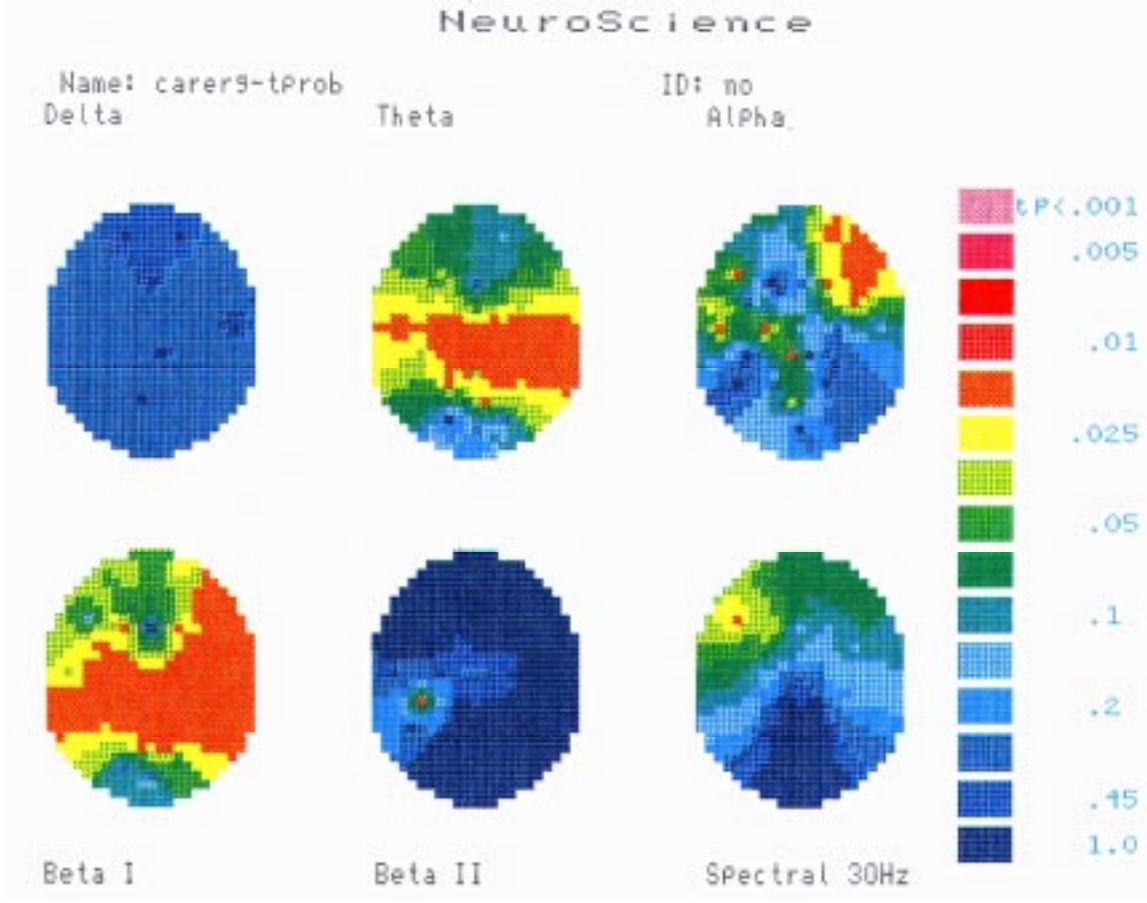


- **EEG-Power decrease on beta, theta and delta range**
- **Alpha activity in the left rear increased**

EEG-Movie post?!

T-Test of the Group Averages

ABBILDUNG 7. **Probability-maps for change of the Group averages from baseline state to altered state**



Discussion

1) Comparing those two states (baseline and altered state), the right hemisphere of the brain underwent changes.

Comparing the states with and without Cannabis (see Abbildung 5 + 6) the most significant alterations can be found on the beta I (12-16 Hz) and theta band (4-8 Hz) on the right hemisphere of the brain, as well as along the *sensory-motor cortex and association areas.* Regarding the alpha wave, alterations were found in the right frontal hemisphere. Thus, main alterations are found in those regions of the brain that are in

charge of the emotional, intuitive, imaginative and gestalt-shaping processes of consciousness.

This may be due to similar findings of intensified cerebral blood flow after THC-Exposure (Mathew & Wilson 1993) and possibly indicates here an intensified awareness of body functions and feelings related to the ongoing motion in the perceived musical time-space. Findings on *changed time perception* and temporal desintegration of events caused by Cannabis-induced disturbances (‘speeding up’) of the inner clock (Melges et al. 1971; Melges et al. 1970) supports this interpretation. With Cannabis time seems to run slower and it appears as if you are watching periods of time through a looking glass, but subjectively more things and events are experienced and present at the same time; a reverse relationship appears.

Interpreted in the stance of informational filter theory (Broadbent 1958) the complexity of all sensory and motor data and their neurone ensembles are filtered through differing conceptualisation systems of the brain and ‘useless’ information will be censored (Emrich 1990). Only a small amount of sensory and intentional motor-related information patterns is consciously present (Keidel 1975).

Cannabis-induced subjective expansion of auditory metric units (Globus & al 1978) may lead to a certain kind of insight into the space between the normal auditory information processing patterns, so that one can ‘see shapes’, that are normally censored (Emrich et al. 1991). One ‘sees’ and feels more information patterns and experiences, feeling that the period of time is extended and the course of time is slowed down. It looks like as if *Cannabis triggers a certain kind of insight into the mixture of moving musical time-space patterns* and allows -temporarily- to overview and process more auditory information at the same time.

2) EEG power on the delta, theta and beta band decreased

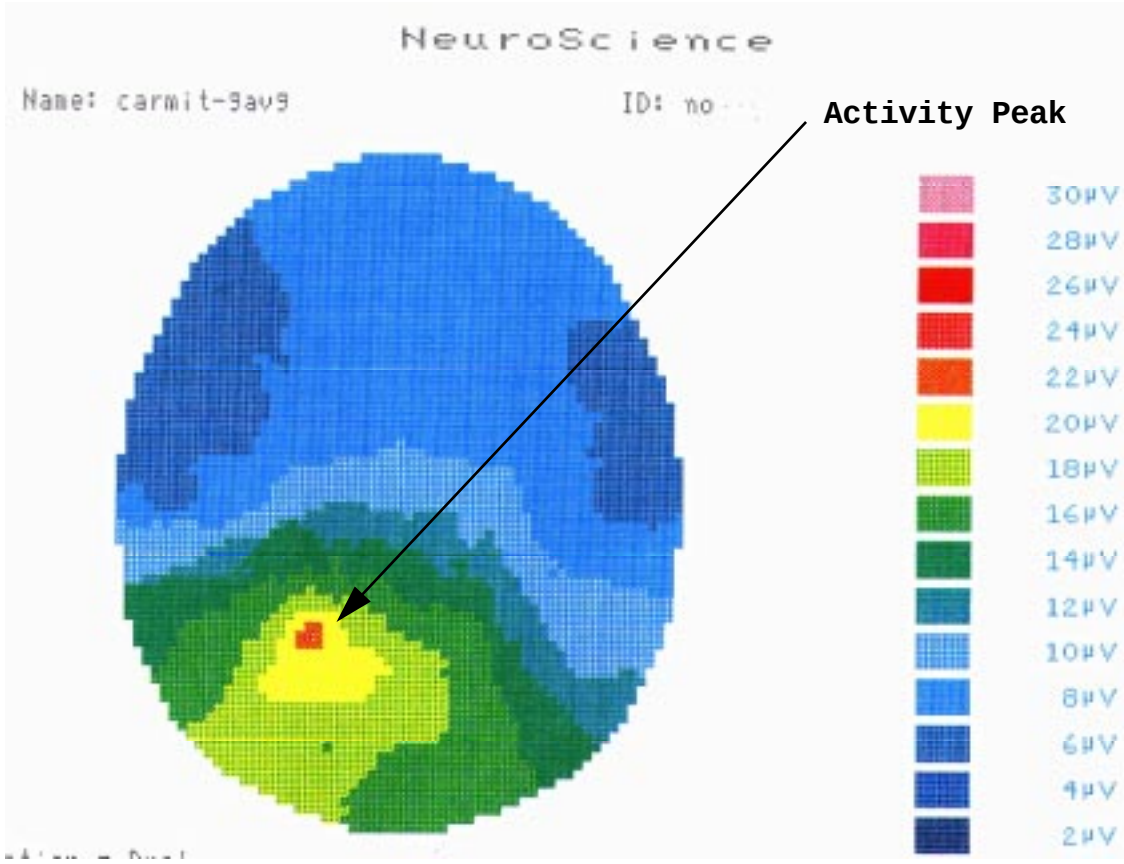
Cannabis-induced decreased EEG-activity on the beta-, delta- and theta ranges (see Abbildung 4 auf Seite 6; Abbildung 6 auf Seite 8) is a known finding in Cannabis research (Fink et al. 1976). Decreased activity does not mean cerebral impairment and indicates states of *relaxation*. Patients suffering from psychogenic tension cephalea are known to show an increased Level of activity on the beta-range, they seem to "worry too much about things" but relaxed people show less beta (Jacobs, Benson & Friedman 1996). Relaxation, euphoria and the state of being “high/stoned” is caused by THC-interaction with brain reward systems (Gardner & Lowinson 1991). The relaxation effect of Delta-9THC on the muscles/tension is discussed for using in medical therapy (Hagenbach 1995; MAURER et al. 1990).

Again a reciprocal relationship, here of decreased brain activity and the subjectively reported state of being “high” or “stoned” leads to an understanding of a Cannabis-induced *contemplation* process, i. e. that the “stoned” person with his sensitivity is much more consciously present in the peripheral areas of the nervous system. The conscious perception of the sensory information patterns is much more intense and in a broader range than in a normal state. By being consciously ‘sunken in the body’ he is getting more sensitive to the information patterns coming from the nervous tracks of the receptors and sensitive nerve cells to the neural pathways of the corresponding brain areas.

3.) The alpha activities in the left rear hemisphere increased, especially in the merging of visual and auditory sensory association areas around the EEG measuring point P3 - possibly a synesthesia- effect?

Increased Alpha-activity refers also to a state of relaxation and euphoria (Lukas, Mendelson & Benedikt 1995). A spatial distribution of Cannabis-induced altered frequency ranges has been rarely investigated yet (Struve & Straumanis 1990), but the EEG-Brainmapping used here allows us to observe spatial resolution of a frequency activity. Dominant cerebral activity in the left hemisphere of the brain refers to analytic and rational aspects of consciousness. Accordingly, dominant activity shifts to the right hemisphere would be a sign of an emotional way of perception. The shape of frequencies in the active areas seen here represent an EEG of the individual hearing strategy in terms of attentive listening to music with closed eyes. Moreover, in the Cannabis-induced altered state, it shows an increase in alpha-activity (with amplitudes rising Ì 4-6 microvolts) in the left rear (parietal-occipital) hemisphere, the receptive part of the brain, especially around the EEG measuring point P3 (Abbildung 8 auf Seite 13). Around the EEG measuring point P3 is a tertiary association area, which parallely processes complex auditory and visual circuit connections. It is located between the sensory speech centre (Wernike area) and the primary optical Cortex area, the calcarine fissure. Thus, the increased activity around point P3 may be regarded as the result of cross-modal, ‘synaesthetic’ processes between the visual and auditory association areas of the upper brain. Cytowic concludes synesthesia as a left-hemisphere function in relation to the hippocampus (Cytowic 1995). The hippocampus is considered to have an influence on perceptual filter functions and interestingly cannabinoid receptors are located in this area (Adams & Martin 1996). This topographic EEG-finding of an increased alpha amplitude activity in the left hemisphere might be an neurophysiological linkage for synaesthetic perceptions and experiences related to music of this person in the Cannabis-induced altered state.

ABBILDUNG 8. Increased alpha-wave-activity around P3 in altered state induced by Cannabis



Conclusion

By all possible means of data interpretation, we have to be aware of the fact that the data was gained from a relaxed sitting person in a non-laboratory private setting, with a EEG-Cap on his head, listening with closed eyes to his favourite music.

Regarding the phases of Cannabis intoxication (Baudelaire 1988; Blätter 1992) results discussed here reflect mainly Phase II in a contemplation and listening processes.

This single case study allowed an event-related generation of average brain activity values through EEG Brainmapping for music listening in normal and altered state. It was possible to represent alteration probabilities for the various (topographic) regions of the cortex. By separating activation parameters of neurophysiological relevance, such as the alpha-, beta-, theta- and delta waves, processes of contemplation can be analysed separately as well as evaluated with regard to their brain topography. Thus, it is possible to make specific statements about typical patterns of brain activity during chosen and given perception processes and alterations caused by Delta-9-Tetrahydrocannabinol

We are -possibly- looking at a state of an auditory cerebral system whose function has not been fully discovered and examined yet. It may be described with regard to the existing knowledge and literature as follows:

the cerebral bloodflow increasing in the right hemisphere of the brain transports the biocatalystic substance THC from the lungs to the brain where it combines with the cannabinoid receptors, triggering the Activity State of the natural neurotransmitter anandamid. As a result, the total input from the sensory system will be lowered, recorded as less activity on the EEG. The remaining activity is centred at a specific region in the brain on a certain frequency band (alpha band). The factor determining which region will be activated and which synaesthetic effect will be produced can probably be found only in the individual himself with his strategies of processing, more or less aware, the information received. It also depends on what the person is doing at that moment and this activity will be experienced in a more intense way than in the normal state. In our case, this intensity refers to the way the musical information is selected by the individual. I.e. some listeners tend to concentrate on the techniques behind the musical structures (using

the left side of the brain), while others (tend to) associate emotions and pictures with those structures (using the right side of the brain).

A Cannabis-induced neural linkage between the acoustical and visual centres of the brain (tertiary projection areas) produces a synesthesia effect. This result can be concluded from the reciprocal relation of decreased brain activity and an intensified quality of sensory perception experienced by a person in an altered ("stoned") state of consciousness, with the amplitudes on the alpha-wave-band rising at P3 with an average of 4-6 microvolts.

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References on Consciousness by Th. Metzinger

Weblink to Alliance Cannabis as Medicine (ACM)