Proceedings of the 7th Triennial Conference of European Society for the Cognitive Sciences of Music (ESCOM 2009) Jyväskylä, Finland
Jukka Louhivuori, Tuomas Eerola, Suvi Saarikallio, Tommi Himberg, Päivi-Sisko Eerola (Editors)

Out of Time? Music, Consciousness States and Neuropharmacological Mechanisms of an Altered Temporality

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ABSTRACT

Drug-induced altered temporality is a well-known effect of cannabis action that is utilised from musicians and music listeners for music appreciation since the early days of jazz. Cannabis has an influence on timing processes at short time scales of hundreds of milliseconds as O'Leary et al (2003) have shown in their tapping studies, proving evidence of an altered cerebellar functioning. This paper will focus on cannabis and its action on timing and aims to discuss selected scientific streams of research on the neurophysiological and neuropharmacological base of timing mechanisms in terms of an social pharmacology of music (Fachner, 2009). The mechanisms behind this altered temporality remain unclear. Generally, task-related and activated neural networks (discussed are thalamo-cortico-striatal circuits, i.e. basal ganglia, supplementary motor cortex, prefrontal cortex, posterior parietal cortex) are serving as a timekeeper and are detecting coincidences in synchronous brain activation and processing of different neural populations. "The scalar property derives from the assumption that the accumulation error is proportional to the criterion duration" (Buhusi, 2005, 756) and this may reflect the consciousness state of a subject and its cognitive and attentional behaviour during time processes in state-related accumulation processes. Clock speed (pacemaker) can be influenced by dopaminergic manipulations whereas memory processes (reference) can be influenced by cholinergic manipulations.

I. All that Jazz…

"*Since time is the axis for perceptual reality, transcendence of perceptual reality would seem to involve alteration in time perception. Thus, the effects of the purportedly consciousness-altering drugs on time perception should be of interest." (Mathew, 2001, p. 46)*

That cannabis has an effect on music perception and production was first discussed in the public and by scientists when jazz in the 1920s entered the stages of contempory music (Leonard, 1962; Musto, 1999; Sloman, 1998). We are confronted with many notions made by musicians and also music listeners that cannabis seem to be of interest for their music appreciation (Boyd, 1992; Jörg Fachner, 2006; Fraga & Lopez, 2004; Shapiro, 2003; Winick, 1959). Today, no matter which popular music journal you would scan for it there would be at least one story mentioning drug use and popular music culture (Manning, 2007).

Drug-induced altered temporality is an important feature that can be used creatively for free musical activities like improvising but can hinder exact playing i.e. of sheet music in an orchestra or big band as well (Behrendt, 1956; J. Fachner, 2000a). In 1943 Piel reported in the 'Life' magazine that a swing musician reaches new heights of virtuosity under the influence of cannabis (in Aldrich, 1944, p. 431). The physician Walton denied improved performance, believing deterioration more probable, but he confirmed "an increasing sensitivity to sound and a keener appreciation of rhythm and timing" (ibid.). He expected such effects only in the early stages of marihuana consumption. Reduced inhibitions might unearth latent talents or evoke a more intensive emotional performance. The established opinion at that time was that the subjective assessment of one's own performance is improved by marihuana, and that individuals taking cannabis have more self-confidence. Aldrich came to the same conclusion in his (Seashore-) test of musical abilities.

Reduced inhibition certainly may induce individuals to try things they did not believe themselves capable of. John Hammond for example complained, however, that marihuana "played around like hell with time perception" (Shapiro, 1989, p. 39). Becker quotes a musician on his first experience with cannabis:

"We played the first tune for almost two hours – one tune! We got on the stand and played this one tune, we started at nine o'clock. When we got finished I looked at my watch, it's a quarter to eleven. Almost two hours on one tune. And it didn't seem like anything. I mean, you know, it does that to you. It's like you have much more time or something." (Becker, 1966, p. 74)

That marihuana altered time perception, seemed to disturb not only a few musicians, for example in playing a defined arrangement. The Head of the US Drug Enforcement Agency in the 1930' Harry J. Anslinger, also seemed to find it a nuisance, as turned out in an interview of Sloman with Dr. James Munch, a co-worker of Anslinger over many years. On the question why Anslinger was about to put Jazz musicians into prison Munch answers:

"Because the chief effect ... is that it lengthens the sense of time, and therefore they could get more grace beats into their music than they could if the simply followed a written copy. ... In other words, if you are a musician you're going to play the thing the way it is printed on a sheet. But if you're using Marihuana, you're going to work in about as twice as much music in-between the first note and the second note. That's what made jazz musicians. The idea that they could jazz things up, liften them up..." (Sloman, 1998, p. 146/147).

The idea based on a subjective experience that an altered and here expanded perspective on or inner representation of time can be used creatively especially for improvisations. This mostly holds true for the soloist who can expand in his jazz improvisations while the pulse is kept under control from the rhythm section of the band or for all of the members in collective improvisations. An early illustrative description of such moments is given from Mezzrow (1946), when he described his first experiences of marihuana on his musical performances.

II. Timing, time perception and production

For musical purposes timing is an essential process of contextualising temporal patterns of interonset intervals between the end and the onset of a new tone, of realising and articulating different length and relations of tones in a given musical structure, from which timing profiles can be generated. If cannabis is changing the inner representation of time passing by influencing the neural networks and their corresponding oscillations responsible for the cognitive realisation of time judgements while performing and perceiving, this must have an affect on realising timing and expression in music. So if Cannabis has an influence on timing processes at short time scales of hundreds of milliseconds as O'Leary and colleagues (2003) have shown in their tapping studies, proving evidence of an altered cerebellar functioning, then the question may arise how an altered temporality can be used creatively from musicians as well as for music listening under the influence.

In a recent review a differentiation of "multiple timers for multiple timescales" have been described and three main ranges have been identified (Buhusi & Meck, 2005):

1) Time processes coordinated in the Suprachiasmatic Nucleus referring to biological cycles like hunger and sleep. Musicians and listeners are influenced from this processes in their personal set of daily changes and fluctuations of physiological conditions

2) Interval timing in the second to minutes range is cognitively processed and is related to attention and decision-making. It is mostly explained with the heuristics of a pacemaker-accumulator model and its task-dependent -and I would like to add state-depended- corresponding scalar property and expectations during time reproduction tasks in subjects. Generally, task-related and activated neural networks (discussed are thalamo-cortico-striatal circuits, i.e. basal ganglia, supplementary motor cortex, prefrontal cortex, posterior parietal cortex) are serving as a timekeeper and are detecting coincidences in synchronous brain activation and processing of different neural populations. Clock, memory and decision stages can be separated. Regularly emitted pacemaker pulses (clock stage) are temporarily stored in an accumulator and a task-related number of criterion pulses is stored in reference memory (memory stage). Time processes and their criterion durations will be referenced in memory and subjective responses (decision stage) can be plotted against a range of task-related scalar expectations. "The scalar property derives from the assumption that that the accumulation error is proportional to the criterion duration" (Buhusi & Meck, 2005, p. 756) and this may reflect the consciousness state of a subject and its cognitive and attentional behaviour during time processes in state-related accumulation processes. Clock speed (pacemaker) can be influenced by dopaminergic manipulations whereas memory processes (reference) can be influenced by cholinergic manipulations. On this time range, for example, music is influenced in phrasing and attention to melody and rhythmic changes during listening and playing.

3) Autonomous time processes in millisecond range referring to motor and perceptual processes mediated in the cerebellum. Music and its timing processes are reflecting the accuracy of performance. Interonset intervals and expression are crucial for rhythm and melodic timing.

A. Methods and categories of research related to time perception and production

In the research literature on timing and behaviour, investigations have focused on motor timing, e.g. the temporal organisation of motor acts, like speech or walking and further on time estimation, e.g. perceiving, estimation, production or discrimination of temporal intervals or delays. Rhythm tasks e.g. by finger tapping according to rhythmic stimuli variations are used in such investigations as well. Rubia suggests that same brain centres are involved in the processing of motor or perception timing tasks. Reviewing literature on the neural correlates of cognitive time management she suggests that both modes vary task specific but cannot be separated (see Rubia & Smith, 2004, p. 330).

Rubia and Smith plotted results of studies against a matrix of brain centres discussed as being targets for time processing in the brain. Although it is obvious that certain brain centres are responsible for more then only one located function it is interesting that the target centres reviewed like basal ganglia, cerebellum, parietal lobes are also known to host most cannabinoid receptors (L. Iversen, 2003). So we may expect that the cannabinoid receptor system (CBR) be interrelated with processes of time perception and production.

B. The cannabinoid receptor system (CBR) and memory

One of the functions of the brains cannabinoid receptor system (CB1) and its endogenous ligand Anandamide and 2AG is to act as a neuroprotector and -modulator, in order to regulate the brains ability to 'wipe out' unnecessary memory storage and devastating neuron firing. It is working like a feedback system that tells neurons involved stopping firing when the message in the target area has been already received. It helps to set the body into a state of recreation and relaxation, to reduce anxiety and pain, to protect nerve cells against cortisol and other stress hormones (L. L. Iversen, 2008). This may also offer one explanation why musicians prefer cannabis consumption more than other artists (see Kerr, 1992): besides possible influences on their creativity it works like a relaxation remedy before and after demanding stage performances or in stress experienced while being on the road (Shapiro, 2003).

However, it was shown that knock-out mice with no CBR were not able to cope adequately with moments of stress (Bilkei-Gorzo et al., 2005; Marsicano et al., 2002). Their memory was stuck on brain circuits providing stressful and averse information compared to those mice with the CBR; they were able to learn some experimental procedures much faster. But as they could not forget about how a conditioned stimulus was related to pain induction, they showed more stress reactions when the learned stimulus and its anticipated fearful pain induction were present. In the long run the knock-out mice grew older much faster, developed damage on the hippocampus and learned worse than other age matched mice because neuroprotection did not happen without CBR. Emrich discusses the brains and persons general need to be

able to forget what is judged as being not needed anymore for further activities in daily life (Smith & Emrich, 1996).

Of further interest here are high densities of CBR in the hippocampus and cerebellum and their inhibiting and exciting action on neurons in this regions during task-dependent information processing. Emrich discussed the role of an cannabis-induced censorship impairment of the hippocampal comparator system during bottom-up processing of sensual information comparing incoming information with learned and stored concepts of reality in memory (Emrich et al., 1991). This weakened censorship is due to an overload of many possible conceptual hypotheses about perceived phenomena rushing into and out of memory.

The cerebellum is associated as being active in the millisecond range of motor behaviour and their temporal coordination. Studies on Multiple Sclerosis and Tourette syndrome have shown that motor behaviour can be improved with cannabis for patients (Grotenhermen & Russo, 2002; L. Iversen, 2003; MullerVahl, Kolbe, Schneider, & Emrich, 1998). As Mathew has shown, cannabis increased blood flow in the cerebellum and in O'Leary's study it significantly induced an overestimation of time intervals (< 1second) of normal subjects (Mathew, Wilson, Turkington, & Coleman, 1998; O'Leary et al., 2003). Hippocampus, cerebellum and CBR action have to be taken into account for our question of an altered temporality induced while being under the influence but also in normal time processing related to the action of the endogenous CBR system.

C. Time perception from a neuropharmacological perspective

Observing the representation of time intervals in the second to minute range psychoactive substances like amphetamines act on the dopminergic system in terms of an acceleration of the internal clock, while sedative pharmacological agents like haloperidol slow down the inner clock (Meck, 1996).

Although localisation of a hypothesized internal clock is not finally solved it is discussed that oscillations and firing of neurone assemblies in terms of clock speed build a time system in the brain (see above) that is responsible for time perception and production integrating events in the environment (Buhusi & Meck, 2005).

Two major clock patterns disturbed by psychoactive substances have been described: Dopamine D2 receptors are discussed to play a major role in temporal integration and dopamine-glutamate interactions control such processes in the basal ganglia. The memory for temporal events and attention to it seems to be linked to the acetylcholine function in the frontal cortex. „ These two systems are connected by frontal-striatal loops, thus allowing for the completion of the timing sequences involved in duration discrimination." (Meck, 1996, p. 227)

Meck illustrates this by a given oscillation of baseline clock-speed at a 100 pulses, which are learned to have a chronological duration of 20 seconds. If clock-speed is accelerated by pharmacological agents the 100 pulses will be accumulated „earlier in physical time than during the baseline training" (Meck, 1996, p. 236) while decrease of clock-speed will be accumulated later than physical time. Summarised this means faster clock speed makes events last shorter while slower clock speed makes events last longer.

But this process can be influenced by learning experience and the corresponding reference memory. Reference memory maybe state-specific relearned to represent the duration of 20 seconds as a clock-speed of 75 pulses. THC-induced changes of a temporal experience maybe explained as a „modification of the memory-storage speed" but seems to act on both systems in the basal ganglia and the frontal cortex with the cannabinoid receptor system interacting with the dopamine and cholinergic system leading to the effect of an „increased clock-speed with decreased memory-storage speed" (Meck, 1996, p. 238).

Lieving et al (2006) discuss Meck's elaborations and explain the role of THC in timing as an acceleration of clockspeed mediated via an increase in activity of dopaminergic neurons, while the anticholinergic action of THC expands the duration of a remembered event. „The more acetylcholine is present, the shorter the remembered duration of events." (Lieving et al., 2006, p. 182). A higher clockrate will improve temporal resolution and subjective estimates of duration will extend. In review it may seem that events were passing much faster then being recognised as described above by one of the musicians who was surprised that one piece of music lasted two hours.

Rammsayer in his studies has discussed the difference of short-term memory depending on dopaminergic activity in the basal ganglia and working memory mediated by cognitive control, whereby working memory is mainly involved in processing of durations longer then 500ms. Short-term memory "refers to the number of activated elements whereas working memory comprises the activated elements as well as for example, processes necessary for maintaining the activation of memory units, focusing, dividing and switching of attention" (Rammsayer, 1999, p. 281) In Rammsayers temporal discrimination tasks of estimating the interval length of two auditory intervals the dopamine receptor antagonist haloperidol affected temporal processing of tone durations in second range as well as in millisecond range below 500 ms, whereas the cholinergic antagonist scopolamine did not. Scopolamine was discussed to have an influence on attentional and sensory processes but not on memory functions per se, while short-term memory processes influenced by dopamine activity in the basal ganglia would refrain from cognitive control.

The role of the serotonergic system on time processing was investigated with Psilocybin, a psychoactive fungus, known to change subjective time perception (Wittmann et al., 2007). The authors authors reported changes in interval timing, i.e. a shortening of subjects reproduction of temporal intervals longer then 2,5 seconds, an impaired sensomotoric synchronisation of inter-beat intervals longer then 2 seconds and found a pre/post slowdown of preferred tapping tempo rates. As psilocybin action is mediated via the serotonergic system the authors were able to demonstrate an influence of the serotonergic system on temporal processing, causing change of internal time duration representation and discussed drug-induced changes of cognitive functions in terms of working memory impairment and accordingly measured changes in consciousness state as responsible for the slowing or shortening in the 2-3s range.

As outined above, CBR action will show an influence on all this neuropharmacological systems, it works as an overall inhibiting agent that can even inhibit inhibiting receptor action, i.e. it activates them.

III. Cannabis and temporal processing

Euphoria, the first cannabis action stage is accompanied with an acceleration of thoughts, associations and ideas and time therefore can be experienced as shortened, especially for experienced users, while an inexperienced user may experience the mood change with an accelerated pulse and blood flow as frightening and will estimate this experience as prolonged (see Wendorff, 1989, p. 89). Tinklenberg further has investigated processes of temporal disintegration and discontinuity that may happen after large doses of cannabis. This results in the experience of an extended ‚Now' and sheds a light on counterculture focus ideas on drugs and spirituality (Taeger, 1988) and corresponding experiences to be made in the 'here and now' (J. Fachner, 2007). Fritzsche argues that an experience of altered time and here especially timelessness and "disintegration of the subject–object boundary feelings of ecstasy and mystic union with the 'immortal' " (Fritzsche, 2001, p. 640) has always been of interest in the search of "transcending our perceptual reality" (Mathew, 2001) to experience the divinity mediated through drug action. Dawson dicussed an cosmic experience of timelessnes of one subject after walking and listening to music experiencing a cosmic time travel under the influence of LSD (Dawson, 2001).

Perception of time and perception of space change under the influence of cannabis, mainly reported as an expansion effect. Time seems to flow more slowly and is overestimated. 95 % of 151 persons interviewed by Charles Tart for his study agreed to the following statement: "Time passes very slowly; things go on for the longest time, (like one side of a record seems to play for hours)" (Tart, 1971, p. 75). This result may proof that listening to the record, here proposed as an example, may result in an expansion of time because the listener is interested to listen and has experienced that before. But it may also be true that it was experienced as boring and therefore expanded because he or she was not interested in it.

Cannabis has been tested with time estimation, but mostly with time production tasks and produced „consistent effects on performance" (Lieving et al., 2006, p. 173). In estimation tasks time estimations increases, a 10-s stimulus would be estimate as lasting 12-s, and in time production tasks, when an individual is asked to produce time intervals with tapping, internal counting etc. same happens vice versa, a 10-s tone would be estimated as 8-s. This „effect has been interpreted as an overestimation of time" (ibid.). Early research on cannabis and time interval perception and production discussed that cannabis speeds up an internal clock so that physical time seems to pass more slowly. This leads to different effects in terms of time perception and production.

D. Estimation tasks

Jones and Stone (1970) asked test persons to estimate a time unit of 15 seconds. Prior to cannabis consumption, estimates were almost exactly 15 seconds, and afterwards 16.7 seconds on average, with a distribution up to 19 seconds.

De Souza et al (1974) asked test persons to estimate the duration of one minute. In the placebo condition, the wrong estimations by 25 test persons had a span of 7.1 seconds. With 20 mg oral Δ^8 THC the span doubles to 14.5 seconds – simultaneously with an increase in subjectively perceived effects.

An inner count of temporal units demands a rather stable, internally represented sequence of chronological temporal units. But if we perceive time as 'expanded', the counting time of the metre changes as well as the relation to the internally represented chronological time unit. Hicks' study revealed an acceleration of subjective time rate in internal counting of subjectively represented seconds and in not counting, "i.e. the rate at which subjective time passes relative to clock time" (Hicks, Gualtieri, Mayo, & Perez-Reyes, 1984). He concludes from these results that the experience of time and its course changes altogether, and not only the memory of duration of time after a time interval.

Melges et al. (1970; 1971) tested changes in time perception under cannabis influence experimentally and observed that small and medium-sized marihuana doses produce a quicker inner flow of time. This means that time as shown by the clock appears to pass more slowly. Higher doses may evoke a feeling of timelessness. Compared to ethanol and placebo, marihuana induced "a significant under-production of time intervals, suggesting an acceleration of the internal rate of time perception" (Tinklenberg, Roth, & Kopell, 1976).

Tinklenberg (1976) asked to rate (produce) 3 intervals of 30, 60 and 120 seconds. Subjects said "30" when he thought 30 s had elapsed, "60" when he thought a total of 60 s had elapsed, etc. and then calculated the differences of subjective measures with objective time elapsed. Cannabis effects were more prominent in the tasks to produce a 60 or 120 second interval. In the production task subjects underestimated 60 sec and rated the interval length to short (i.e. 50 sec). In a time perception (estimation) task "when asked to estimate the duration of a 60-s buzzing sound, they will tend to overestimate and state the sound's duration was 70 or more s." (Tinklenberg et al., 1976, p. 278)

The onset of this acceleration of the inner clock which makes chronological time processes appear slower corresponds to the characteristic increase in heart rate and subjective drug effects. Mathew et al (1998) performed PET and MRI tests with persons who showed altered time perception and found reduced blood flow in the cerebellum.

E. Temporal disintegration – or focusing on the moment

Apart from changed time perception in respect of duration, there is also confusion of past, present and future and, in addition, an alteration of temporal perspective. "A subject becomes less able to integrate past, present and future, his awareness becomes more concentrated on present events; these instances, in turn, are experienced as prolonged or timeless when they appear isolated from the continual progression of time" (Melges et al., 1971, p. 566).

This means that the span and focus of deliberate orientation to past, present and future changes, in the sense of a stronger focus on the present. In Casswell's studies, test persons were asked to add and subtract numerical proportions and to react to a temporal sequence of stimuli. Cannabis consumption

impaired the temporal consistence of their activities and reduced concentration to a short period (Casswell & Marks, 1973).

So cannabis appears to change the experience of time more in the sense of a kairological time perception and to decouple external time concepts from internal experience. A heightened awareness of 'personal time' (Nowotny, 1993) serves to focus on the present and the experience of the special moment, the personal situation, to experience and evaluate it in an altered metric frame of reference (J. Fachner, 2000a, 2000b).

In general we look at a reciprocal relation: Processing structures of information in the here and now seem to happen faster. This phenomenon is mainly experienced as an extension of time. The inversely proportional intensification of time perception as a slowing down of time intensifies the awareness-related presence of the sensory stimulus and expands the present. The wealth of internal experience makes minutes appear like hours, as told in Becker's quote of a jazz musician cited above. One possible explanation of the over-estimation of time is the quick sequence of ideas and impressions coupled with impaired memory function, since time is estimated on the basis of successive mental impressions. Memory offers access to structures that are either already acquired or must be learned. Hippocampal memory functions are intensely stimulated by the larger clusters of cannabinoid receptors located there, resulting in an temporarily increased access to memory and association patterns, that due to weakened hippocampal comparator and censor function (Emrich et al., 1991) deliberately processed contents will fall out of the 'extended' awareness for contents even faster.

IV. Cannabis and the musical timespace

A consequence of altered temporality for music production is that a larger subjective 'musical timespace' (see Christensen, 1996) for action emerges in improvisation so that decision processes may be addressed and potential observed sidetracks of spontaneous musical development may be forgotten, i.e. cannot and will not be 'held on to'. Improvisation always requires flexible response to emerging musical contents and patterns in the here and now, requires an anticipation of musical events, and demands from the musician coincidental decisions on musical movements to be expected and performed. The temporal extension of perception induced by cannabis may prove beneficial for musical improvisation, may offer 'more grace beats' as allegorised in Sloman' quote cited above.

Is this one reason why musicians in the jazz tradition specifically like(d) the stimulus of cannabis for improvisation? The effects of cannabis on music perception and music production may have been the reason to prefer and produce a musical style that places the rhythmic element of music in the foreground because this element in particular permits to anticipate internally and 'grasp' the temporal organisation and motor structure of improvised music. When patterns of time perception are extended under the influence of cannabis, i.e. when chronological time is perceived as slowed down in the personal, kairological dimension, then this permits temporary insights into the lines between perceptive events, which we normally experience as a sequence due to neurophysiological optimization (Spreng & Keidel, 1963). It is almost as if the flow of time and events might be observed 'under a magnifying glass' and the state-specific metric frame of reference permits insights into the 'space between the notes' (J. Fachner, 2000a; Whiteley, 1992). "I don't know if I can attribute any effects from it [pot] towards the music, unless you want to say it does create a larger vision, and if that's the case, then it would apply to your instrument because the more you see, the more you can do" states the drummer Robin Horn in (Boyd, 1992, p. 205)

It is part of the evaluative strategies for a number of musicians to listen to the mix of newly recorded music once again under the influence of cannabis, as confirmed by members of the Beatles or Fleetwood Mac in a qualitative investigation into the creative process (Boyd, 1992). Sound spaces may be shaped better if the share of high frequencies can be varied. The spatial perception of sound in the sense of an echoing of sound sources is produced by an increase in formant sound pressure, that is, the intensity of characteristic overtones of instruments is increased through echo overlaying of the resonant space. So a variable time factor referring to the resonance time of instruments is added to the audio recording through chances of sound spaces on sound tracks, within the chronological flow of music as a time 'gestalt'. The positioning of instruments and their sound spaces in the mix produces the acoustic impression of a soundscape in a three-dimensional musical time-space.

After cannabis consumption „…a reorientation of perception takes place, the limited visual space disappears, and the acoustic space is perceived as a sphere, with the corresponding reaction" (Curry, 1968, p. 214).

Marihuana seems to intensify the perception of such soundscapes and to inspire their use in connection with altered time perception. Improved perception of higher frequency registers, the overtones and its envelope in particular, appears to be a preferred source of information. Cannabis-induced intensification of auditory perception of high sound frequencies, altered parameters of auditory metrics, and extended temporal and spatial images serve to demonstrate a qualitatively heightened insight into the structures of the musical time-space.

Such considerations can only be discussed briefly in this context and require further exploration and interviews with musicians, listeners and above all studio technicians.

It seems that cannabis does not so much affect music perception itself; it induces changes in the perception of time, frequencies and space, comparable to an enhancer, exciter or compressor in studio techniques, and thereby influences the perceptive focus of spatial-temporal sound gestalts, it's sound staging and in this way may be perceived as an improvement in psychoacoustic quality (see J. Fachner, 2000a, 2000b, 2002a). For someone experienced with the drugs effects it seems to be possible to shape the musical-acoustic temporal space of sounds, their sound staging, in listening, composition and improvisation, due to the drug-induced changes in the altered metric context (Fachner, 2000).

F. Cannabis, Music and EEG studies

EEG studies by Hess and Fachner illustrate that the process of listening is intensified and focussed temporarily and that

individual listening strategies change. Hess (1973) detected frontal and parietal increases of alpha and a decrease in the frequency in correlation to the contemplation phase induced by cannabis. Listening to music revealed the „most obvious signs of hashish smoking“ (Peter Hess, 1995, p. 32), and it was possible to control the altered state through music. Music was perceived as more intensive, details were perceived better, and the sense of time changed markedly while listening to music.

Fachner (2002) analysed EEG brain maps of test persons listening to music with and without cannabis; listeners without Cannabis revealed stronger, those with cannabis revealed weaker amplitudes and frequency quantities across nearly all brain regions compared to rest. But the parietal lobe that coordinates alertness and perception revealed a marked increase in alpha amplitudes while listening to music after cannabis consumption. The literature on EEG discusses alpha increases in reverse relation to cognitive performance („reverse alpha“) as an indication of facilitated mental processing (J. Fachner, 2002b, p. 28ff; Jausovec, 1997).

Rubia & Smith reviewed the role of the inferior parietal lobe in time processing and discussed its role on sustained attention to time intervals as “a necessary basis function for time estimation processes. … The parietal lobes with their connections to fronto-striatal and fronto-cerebellar circuits are thus strategically well placed to support cognitive time management processes by assisting them with sustained attention to time” (Rubia & Smith, 2004, p. 336). If the focus of attention is altered, time processes and their metric frame of reference may result in forms of auditory information processing that temporarily open more insight ‘into the space between the notes’, ‘creating a larger vision’ on music processing.

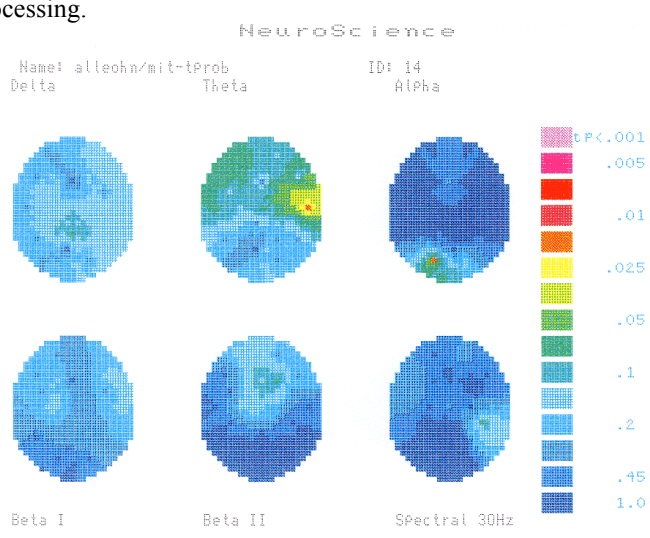

Figure 1: Significane mapping (t-Test pre/post THC qEEG of music listening)

In Fachners (2002b) study theta changes in the right temporal lobe and on the alpha band in the left occipital lobe were significant (p.<025). Occipital changes suggest changed acoustic perception; temporal changes suggest changes in the auditory system, the midbrain and the limbic system. Proportionally stronger concentrations of cannabinoid receptors occur in the regions of the midbrain and cerebellum that mainly process intensity perception, memory, selection, temporal and movement processes. Stimulated by cannabis, this receptor interaction may produce a facilitation and inhibition of cortical processes that become visible in EEG topography, in the sense of focussed attention. A functional expression is a temporarily changed and possibly more effective metric context of intensity, acoustics and rhythm (J. Fachner, 2000a, 2002b).

V. Conclusion

To summarise, under the influence nothing supernatural happens, only a temporarily more intense stimulation of the CBR according to a personal music preference in a given set and setting for the drug experience of listener or musician and this influences his or her focus of attention on the musical time-space. To enable experiences of an induced altered temporality the brain processes auditory and temporal information in an altered metric frame of reference according to what has been previously learned and experienced under the influence.

As Baudelaire has written up his experiences in his poem on hash: “The ear perceives almost inaudible sounds amidst great turmoil. This is where hallucinations start. External objects start to assume a strange look. Then the ambiguities follow, the misunderstandings and alteration of ideas. Sounds dress up in colours, and colours contain music. Some will tell me that this is quite natural and every poetic brain easily conceives such correspondences in a healthy and normal state. But I already pointed out to the reader that a hashish trip does not involve anything really supernatural. But the correspondences are unusually vivid” (Translation from Baudelaire, 1988, p. 43).

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