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NEURO-PSYCHO-PHYSIOLOGICAL AND SOCIAL RESEARCH AND INTERVENTIONS FROM AN INTERDISCIPLINARITY POINT OF VIEW

THE "MIRROR EFFECT" IN SOUND'S FUSION TIME: THE INTEGRATION OF TWO SPECULAR SOUND FIELDS IN ONE MENTAL-VIRTUAL HOLOPHONIC SOUND FIELD. PHENOMENOLOGY AND APPLICATIONS.

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Back

In the 90's our domains of study and research were the psychoanalysis and the study of the recording and reproduction of sound and music.

Regarding the psychoanalytical practice, we considered the verbal communication between patient and analyst as something structured on a triple reference: a linguistic reference that expresses both the literal and the unconscious sense of the words (Fornari F., 1979), and a sonorous reference which represents as a carrier of the affective/emotional communication (Anolli L., Ciceri R., 1992).

This duplication between language and sound can be resumed in the distinction between the "gramma" the and "phoné". We consider the "phoné" (the voice intended as pure sound) as the point of development and contact between the linguistic and musical dimension, the expression of an internal emotional state through rhythm, amplitude modulation and intonation (Fornari, 1984; Agamben, G., 1982; Finsterle G., 1992).

In the field of the audio research one of the most interesting issues was to try to understand which was the essential difference between the listening of a live musical event and its reproduction in a domestic environment with a stereophonic reproducing system. The use the world's best hi-fi equipments allowed us to understand that the difference in terms of perceived sound's quality and emotional involvement ***is not*** only related to a deficit of precision in the reconstruction of the sound waves, but instead it is also related to the difficulty for the listening subject to experience the state of enchantment which occurs during the live listening.

We understood that the way to get over this matter was on the one hand to reproduce a physical sound information as identical as possible to the original live sound. On the other hand, to find a way to induce this state of enchantment in the listening subject, a state that produces a ***modification*** of the quality of the perceived sound, which on the side of sound content and information is perceived as a sound hologram.

The hypothesis that the state of enchantment, conceived as a modulation of the state of consciousness, could induce a new definition of the quality of perceived sound's experience, is the basic idea of the audio reproducing system called AVS Virtual Audio Standard®. A detailed description of this system is published in the NASA Astrophysics Data System (Finsterle, G., US Pat., Harvard, 2003).

The new found method of reproducing sound is recognised as a novelty by the Patents Office's examinators and consists of what is defined "mirror effect". It is easily comprehensible looking at the figure nr. 1.

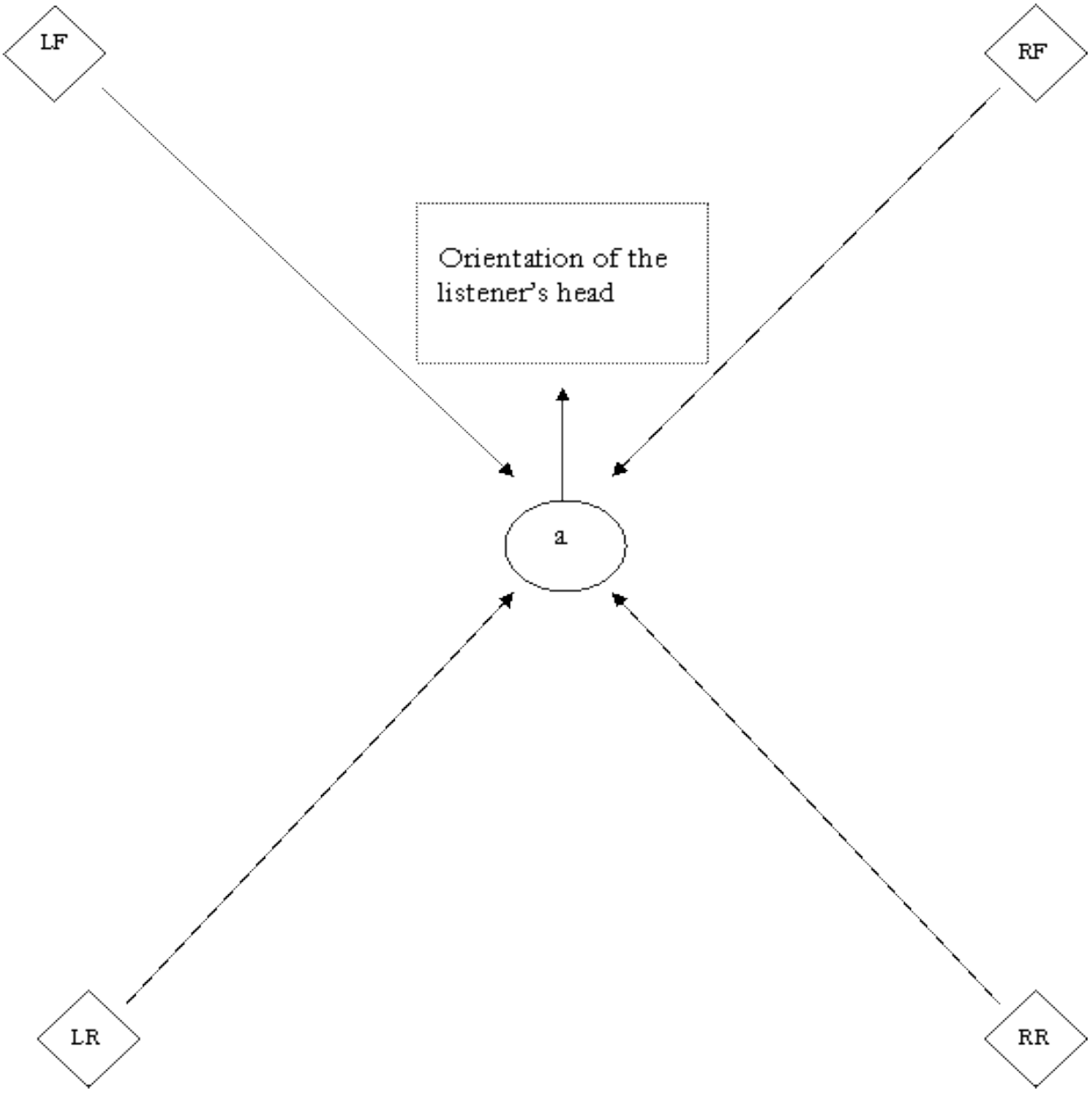


Figure 1

The figure nr. 1 shows the essential structure of this audio reproducing system, that consists of a conventional stereophonic signal sent to the front channels (LF+RF; left front, right front) from the speakers oriented towards the listening point "a", while at the same time the same sound is controlled by a specific electronic called "AVS Perspective Correlator", that sends a similar signal to the rear speakers (LR+RR; left rear, right rear). The rear sound is controlled in amplitude in relation to frontal channels' signal, at determined frequencies and also in time domain, in order that the rear signal comes to the point "a" with a time delay not greater than 16 ms to the signal coming from the front channels. This has no connection to the relative position of rear speakers.

The reason why the ΔT must not be greater than 16 ms is that this ΔT corresponds to what is called the "sound's fusion time". What happens is that if more than a sound is emitted in this portion of time, the auditory system isn't able to distinguish the two (or more) different information perceived, which, consequently are fused in one unique "gestalt".

The concept of "Fusion Time", in a more restricted time domain (approx. 0,5 ms) explains the functioning of the stereophonic system, which is based on the difference between interaural intensity and interaural time (IID and ITD) to allow the reconstruction of a sound field which is perceived in front of the listener (supposing LF and RF speakers placed in front of the listener as shown in figure nr. 1).

What happens if, in addition to the frontal stereophonic system, we also implement a specular rear system that emits the same transient from the back and within the fusion time?

When the four speakers send a sound that arrives in the listening point "a" within the $\Delta T < 16$ ms (with relative amplitude between front sound and rear sound within +9/-12 dB in point "a"), from a physical point of view it is impossible to define the position of the sound events in the sound virtual space. In fact, what is produced is a phenomenon known as "front-back confusion" which consist of a misperception of the position of the sound event. Furthermore, there is the perception of a confused and grainy sound, caused by "jittering problems" in time coding of frequencies (Proceedings 12th Audio Engineering Society International Conference, 1993). The perception of a confused and grainy sound is also caused by the sum of phase-inverted signals in certain frequencies.

From a physical point of view the quality of the sound is poor and the position of sound events in the sound stage is confused. From a phenomenological point of view the discovery that we would like to define is that with ***this*** setting the phenomenon of "front-back confusion" and the related confused and grainy sound is perceivable only for few instants (from 1 sec. to 30 min. during the first listening session, less than 1 sec. from the second listening session). During this time is observed an integration between the two sound fronts (the front and the rear) that opens the listener to the perception of a stable holophonic spherical sound field in which the sound events emitted from the audio reproducing system are placed. Furthermore, the sound event acquires a three-dimensional characteristic – like that of a hologram – which produces in the listener a sense of realism in the sound event perception similar to that of a dreaming or an hallucinatory experience.

In the field of acoustical research it is known that the professional musicians don't like the sound reproduced by the hi-fi sound systems (stereo, surround) because they consider it very far from the sound heard during their performance. In the case of the sound reproduced by correlation of the two front and rear sound fields, the musicians listening to it show an immediate recognition of their own produced sound, though the difference between the event that they perceived during their own live performance and the sound recorded from a couple of microphones placed 2-3 m of distance from the instrument (for example, piano).

The similarity they recognise isn't a sound identity "tout court", but is phenomenologically related to the quality of sound's "texture" (its dynamic and tone micro-modulations) and to its "plasticity" (the sound hologram) as well as to its particular ability to induce in the musicians the whole psychosomatic experience lived during the real execution.

"It isn't like listening the sound to study it like we do at home. It isn't that the effect it produces. It is as if it should be possible to listen ourselves from the "inside" during the execution. What is created is not only the acoustical event, but also the effects which are involved during the execution: the thoughts, the feelings and the *movements.*" (Violinist)

These phenomena (a "recognising period", a re-tuning of the auditory system which creates a 3D sound field, the correlated threedimensionalisation and focusing of the sound image and the access to an enchantment state which increases transmodal passages of information (synesthesia), brought us to think that the human auditory system utilises some of the modalities of creation of the sound field that are active during the producing of dreams. Such modalities are supposed not to be related to the elaboration of IID and ITD information.

In case the reproduced listening experience is effected with stereophonic information, the general hypothesis is that the mind (the auditory system) accedes to a "transitional" way of working, utilizing "algorithms" typical of dreams integrated with the IID/ITD information and elaborated by "algorithms" used during the state of wake.

This consideration brought us to define a procedure to verify the hypothesis of activation in the mind of "dream" functions to elaborate a perceived holophonic sound field induced by the "mirror effect": this

procedure is called “Settingα”.

The “Setting α”.

The basic idea was to create a defined stimulus and setting which allows to have a direct experience of the mental space in which dream realizes itself, space that we define “Primary Mental Space”. This definition is related to the hypothesis that the foetus is already able to build mental events in a three dimensional space, also during dreams, and that this space experience is ontogenetically the first one.

We decided to use an “informal” sound stimulus without recognisable forms in it, almost identical in time and with a constant relation in the distribution in amplitude at the different frequencies. We choose as stimulus the “pink noise”, a sound with a fractalic structure (a = 1/f). We made this choice for four reasons:

1. because it is the electrical background noise emitted by the living systems which self organize their behaviour (Van Orden G.C., Holden J.G., Turvey M.T., 2003);

2. because it has non recognisable forms and it could also be defined as the totality of the “music, speeches and noises” all heard at the same time;

3. because, differently from sinusoidal pure or combined sounds in normal subministration conditions via speakers in a room, the masking effects towards ambient noise, are much more effective and allow to eliminate totally every influence from the location, with sustainable absolute sound pressure levels (SPL), approx 60-70 dB@1kHz;

4. because this sound is very well known and utilized in acoustic measurements and in the psychoacoustic field, where it has been found that in some conditions the PN can facilitate the sleeping process but is almost ininfluent on mental activities, at least with normal SPL (>90 dB/SPL). In this sense we intend this stimulus as *neutral* .

Three other conditions are peculiar to “setting α”:

1. a tuning of ΔT F/R→a and ΔA F/R→a which tend to simulate the physical and phenomenological conditions of a listening session via liquid without auricle, considered ontogenetically and phylogenetically a “primary” condition;

2. the use of a PN signal correlated between L/R, zeroizing IID and ITD, simplifying all the physical variables of the holophonic stimulus;

3. the necessity to close the eyes during the listening session of PN, in order to exclude a spatial elaboration based on visual information and consequently to favourite the perception of internal mental states.

The listening subject must stay alone during the 20 minutes of the listening session.

The phenomenological experience usually starts with the hearing of a sound emerging from a point in front of the subject. This point is perceived within a three-dimensional spherical mental space in which the Self, or more precisely the “self-consciousness”, is in the centre (and border).

The autopoietic productions.

The term “autopoietic” comes from the greek “auto” (oneself) and “poiesis” (creation) and was used by Maturana and Varela (1985) to indicate the essential characteristic of living systems, the fact they are organised structures and are able to maintain and recreate their self unity and autonomy also in the continuous variations of the environment they live in. They create their own parts which, as a

consequence, generate the whole system.

We used this term also in its phenomenological meaning, integrating Fornari's intuition that the mind has in itself a *facultas signatrix* (Fornari F., 1983), that is an autonomous tension which produces signs. This concept is linked to Varela's idea of consciousness as an emerging phenomenon which is consubstantial with the representation of a world and a sense, two dimensions which are not reducible to the bioelectrical functioning of the system that allows them to exist (the brain, the body, in *couplage*, relation, with the physical world).

Autopoietics phenomena, autonomous mind's creations, are different from the stimulus and emerged in different forms and mental spaces in a high percentage of subjects.

In the consciousness' modulation process that happens during the listening session in "settingαa", we distinguish five stages:

Stage 0T: the subject perceives the sound-stimulus maintaining the usual stream of thoughts. No consciousness modulation. (0 = no autopoietic productions, T = presence of normal Thoughts).

Stage 0: the subject hears the sound-stimulus and in a specific moment the spontaneous streams of thoughts stops, bringing the subject in a condition of empty contemplation of the stimulus, in which he/she has a sensation of Being, a sensation well described by Winnicott's definition "sensation of Being before any identification" (Winnicott D.W., 1974). We use the term "self-consciousness", in its meaning of non thetic, non positional consciousness of the Self (Sarte J.P., 1965). The listener is always perfectly conscious, even in absence of thoughts. The sound is perceived, we think, in a mental space in transition between the sound space built by IID+ITD and Probability Hypothesis (sonorous mental space) and the one build during dreams (primary mental space). After 1-3 minutes of listening some subjects report a slight state of anxiety with an increase hearth and breathe rhythm for a few instants. In a short time slower and deeper rhythms of hearth and breathe returns and is associated with a state of deep relax and a sensation of holding and protection.

Stage 1: the subject hears the sound-stimulus that transforms itself in similar, known sound events (the sound of a waterfall, the hiss of an airplane, the sound of the wind, the sea waves, etc.) which are associated by the listening subject to a "visual" mental representation (like a remembrance) and by synestesia also to other events and senses of the experience like the humidity of the waterfall, the chill of wind, etc.. Spontaneous infant remembrances, sensations and emotions can arise in the form of mental representations. This experience appears to be natural, the subject being always perfectly conscious.

Stage 2: the subject hears the sound-stimulus and builds, in the primary mental space that unfolds itself in the sonic transitional mental space, sonic events which are different from the stimulus (music, car noises, bells, the closing of doors, the pure sinus tones, the voices in their phonetic/emotional dimension, ecc.). These sonic events have the characteristic to be perceived from the outside, as it happens with dreams. The subject can decide whether paying attention to these events or not. During listening, some subjects "perceiving" only sonorous events, showed evident REM phenomena. We think that these events unfold themselves within the fusion of the primary mental space with the sonic transitional mental space. The experience appears natural, the subject being always perfectly conscious.

Stage 3: the subject does not hear the sound-stimulus and builds into the primary mental space visual events which are like holograms that forms themselves in the front and behind the listener. These visual forms have the characteristic of an endogenous brightness, which is a property also of the background (the primary mental space). These images appear and disappear like the changing of slides while we project them. We think that these events unfold themselves within the primary mental space. Often the ecstatic-hallucinatory events seems not to be related to the subject's past life events (for example the image of a wonderful yellow flower extremely complex though in his structure it is perceived as "simple"; or geometrical forms like lines, spheres, angles, fluxes of changing colours). The experience appears natural, the subject being always perfectly conscious. Sometimes it happens that the subject gets

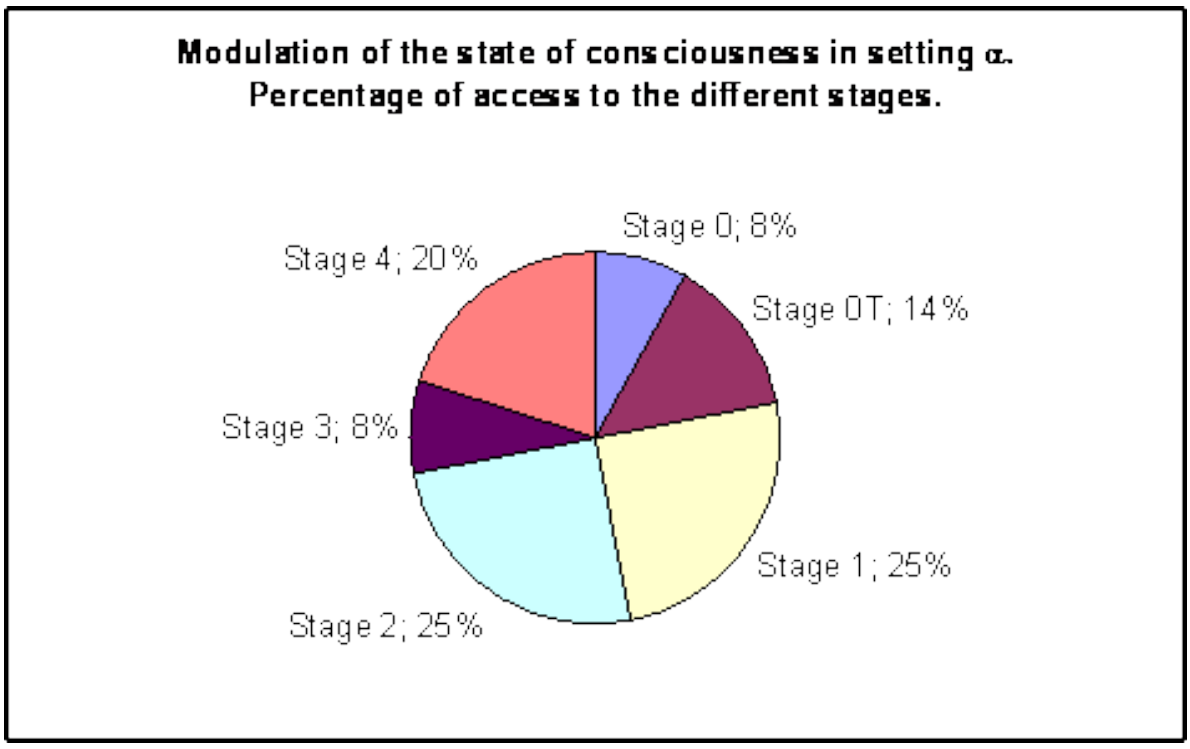
frightened for the unexpected event, but this reaction ceases after the first experience.

Stage 4: the subject does not hear the sound-stimulus and builds complex events into the primary mental space (visual – acoustic – tactile – gustative – olfactory – coenesthesic – emotional) which resemble the animated scenes of a dream. The subject can interact with these events with a sense of realism near to that of a perception. His consciousness can come closer to an "object" using a sort of "zoom function" and he/she can "speak" with another "subject" which is a mind image that answers the listener's consciousness independently from it.

In this condition the subject usually experiences a detachment from the body without loosing the body's mental *imago*. This last imago can move in this primary mental space. One subject (psychiatrist/psychoanalyst) notes he can direct the "plot" following his conscious desire. The hallucinatory events that build the plot seem to be precise memories of the subject, even if not immediately recognised as personal remembrances.

The experience appears natural, the subject being always perfectly conscious.

When the sound-stimulus stops the disappearing of all the ecstatic – hallucinatory events is immediate. Once disappeared these phenomena can't be reproduced by a voluntary act.



Sample of 26 subjects that have made 1-6 sessions. M: 16, F: 11 Age: 21-80

Example of access to Stage 4: Psychologist, F, age 30, 3° session

The experience has been perceived by the subject as beautiful. The subject wasn't disturbed by the EEG. The autopoietic productions lasted for 22 minutes of the listening session. The fade out of the sound corresponds to the "fade in" of the Self in the body.

Phenomenology

"A short time after the beginning of the pink noise with eyes closed I saw a light that gradually became more and more intense, until I had to "close the eyes", that began for a while moving spontaneously

from left to right. I also heard a cyclical sound like that of a siren. It did not bother me.

The sensation I had was like I was flying: I saw all from above. I felt my body heavy, but I felt detached, high flying in the space, feeling very light.

Afterwards I saw a light becoming more and more red. Then I heard the sound of a volcano's eruption and found it was very pleasant. I felt surrounded by warmth.

Then I saw a sheet moved by the wind and a blue light. The blue light became the Caraibic Sea (wonderful) and I saw myself on its surface: I dived into the sea while the colour of the water became more and more a dark blue.

Afterwards I heard a loud sound of balm-crickets and I saw a dark image with many trees on my left and right. I was running in the middle and this was a gloomy situation. Then the sound was turned off and in the meantime I had the sensation to return into my body."

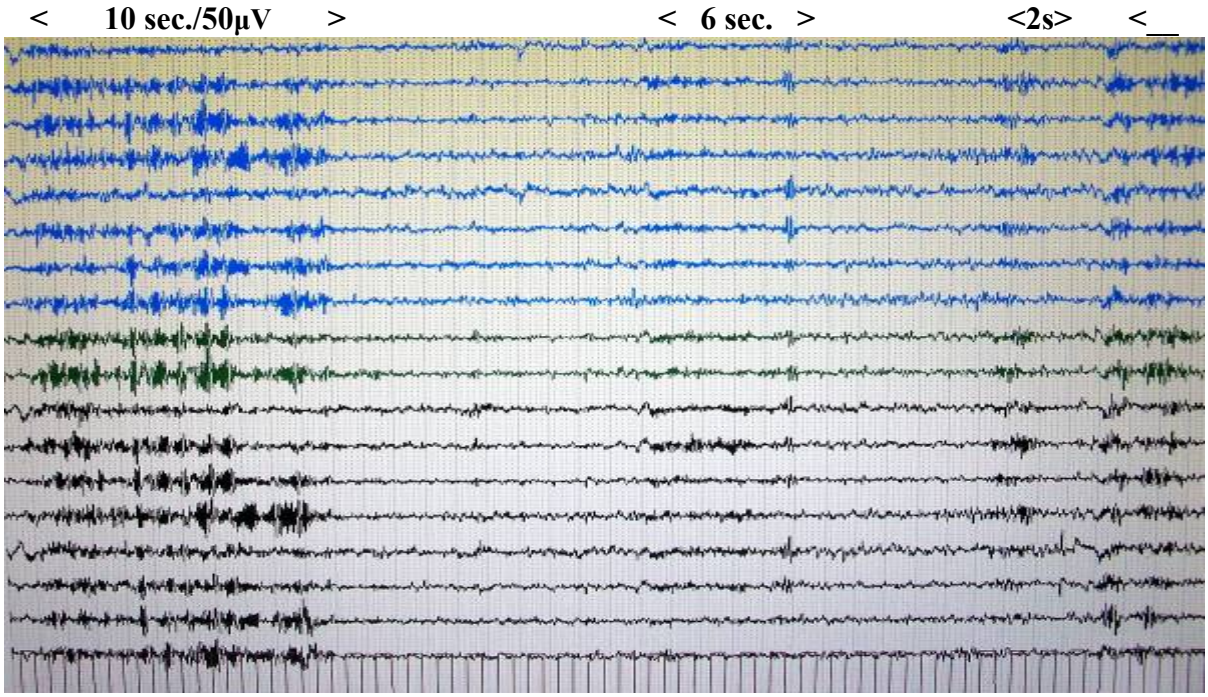
Applications potentials.

As far as we have been able to establish, during the last eight years of research, the listening session executed in "Setting αa", called Psycho Acoustical Transitional (PAT)session, induces a modulation of the state of consciousness which unfolds the perception of a mental space that we think is the space where dreams and ecstatic phenomena (Margnelli M. et al., 1993) are created. This experience increases forms of insight, also because we can observe a disidentification of the Self from the events that unfold in this space.

In a double blind research effectuated to determine cortical activity during PAT sessions, 15 EEG have been recorded. The most interesting data that we observed was a tendency to induce recurrent general cortical synchronisation, in some cases in all bands (α,β,δ,γ), correlated with an evident increase of in-phase neural cortical populations (Aiello G., Finsterle G., 2005).

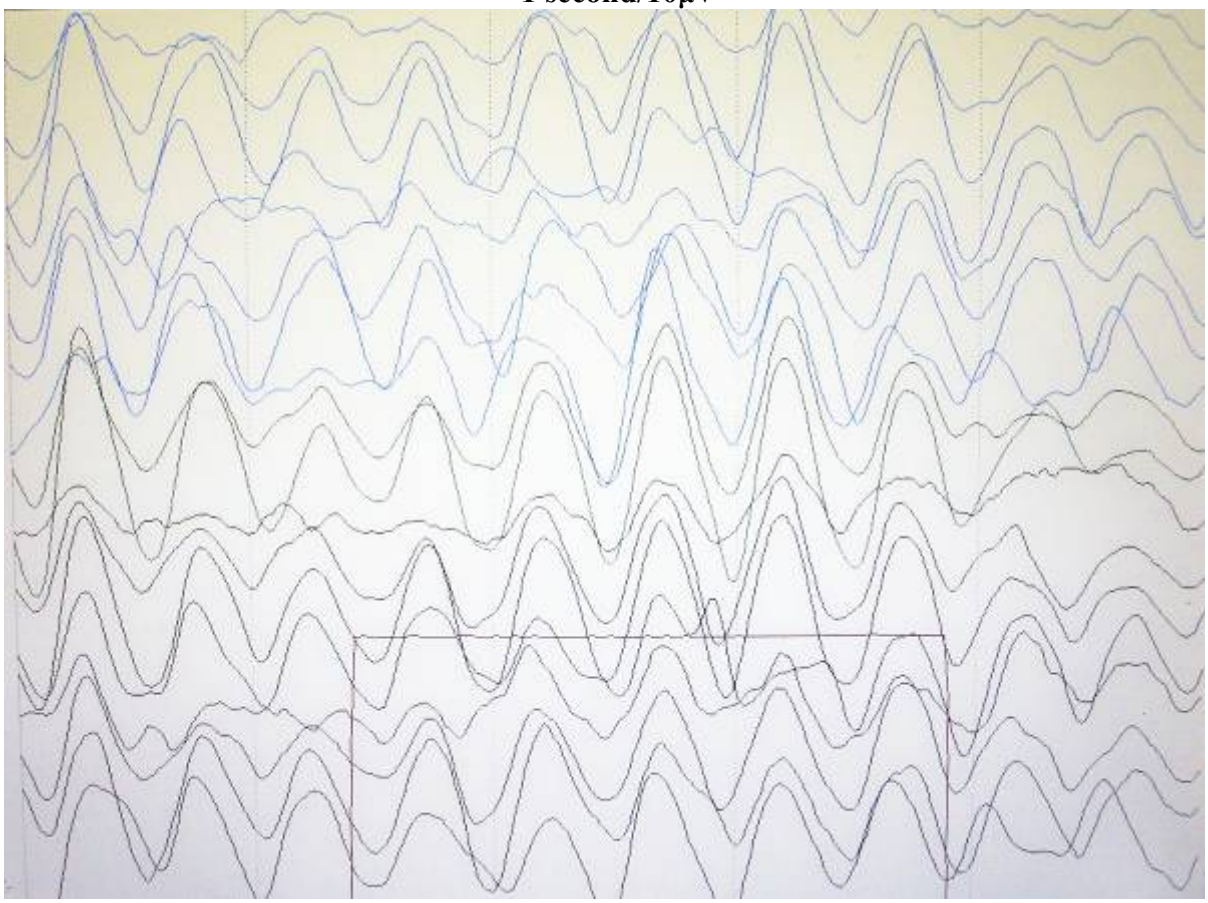
Research on 15 EEG. Subject: F, age 32. Access to Stage 3.

Example of recurrent synchronisation (40 seconds rec.) during PAT session.



Example of 1 second of the first burst: in evidence the general cortical synchronisation.

< **1 second/10μV** >

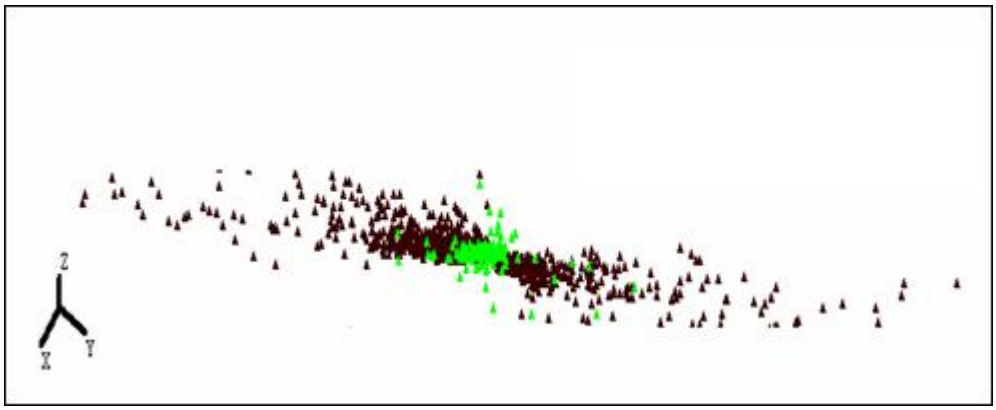


Space of phases.

Green triangles: in phase neural population without stimulus or stereo stimulus, closed eyes.

Black triangles: in phase neural population with stimulus a, closed eyes.

Hemisphere R, during synchronisation.



We believe that the unfolding of this space experience is related to the increase of communication among neocortical areas and between these areas and older ones, that let emerge the activity of primary sense-creation's structures: "the system analyses his own programs". It is interesting to consider that the sound stimulus can be described also as a multigradients synchronized stimulus: a relation between this input and the cortical synchronisations seems plausible.

We think this method of interaction with the mind's functions presents some interesting characteristics for the research in mental field.

1. It is a completely defined setting from a mathematical-physical point of view and doesn't need an interaction with an other subject to produce his effects.

2. The "informal" sound-stimulus bypasses the problems related to the subject's mother tongue and his musical culture.

3. The modulation of the state of consciousness occurs in a high percentage of subjects and are relatively independent from their conscious control.

4. The experience is usually perceived as pleasant.

5. The duration of the session is relatively short (20 min.).

Furthermore, in these years, we have seen that some typical effects lasts for 24-48 hours after the PAT session, independently from the dialogue-technique that may be used after the listening session.

It often occurs that subjects describe a clearness of mind and a physical improvement for 1-2 days after the session. We think that these improvements can have a relation with the opening of new neural communication paths that may be easier to activate, increasing the capability to elaborate information and improving the spontaneous control of the body.

Pianist, Male, 36: description of the effects after a session in setting α a made 3 days before.

"After the early moments of uncomfortableness, that probably moved something inside me I voluntarily put aside, the sensation was "I want to see": I was in front of a point of uncomfortableness, maybe a state that scared me, a internal part of me that scared me. Bypassed this phase, the experience was surprising, unexpected because I lived both something new and I lived these moments in a very natural, comfortable way, in a state of joy and well-being.

The listening of these voices, the presence of musical themes that I heard, the remembering of very definite situations that I developed the days after, surprised me and I didn't forget them.

After the listening, in normal life, the strongest sensation was a different approach to the music: trying to play with this new dimension – I don't know how to explain – I notice two or three very clear points in the musical technical field. The most important feeling was this sense of uniqueness, to play a piece understanding in that moment that it must be so. It's like a musical conviction that isn't rise from thinking, but rises from a state of immediateness and comfortableness to the piano, the hands, the body. All happened in a faster way and this state lasted for 24-36 hours. Then, I felt the moment in which this state disappeared, and now I'm able to synthesise this state with the word "clearness": all was faster, clearer. Even the reasoning, the applications, the evaluation of some persons, the usual conversations with some persons had a new light: it was like I was magically able to interpret the thought of other people. Maybe, the intuition's sensation was stronger and also my language – I lived with a foreign woman and my language became poor – returned to a state of years ago, when I was able to better articulate my thoughts."

Conclusions.

This method of interaction with the mind's functions presents some interesting characteristics for the research in mental field. It is a completely defined setting from a mathematical-physical point of view and doesn't need an interaction with an other subject to produce his effects.
The "informal" sound-stimulus bypasses the problems related to the subject's mother tongue and his musical culture. The modulation of the state of consciousness occurs in a high percentage of subjects and are relatively independent from their conscious control. The experience is usually perceived as pleasant. The duration of the session is relatively short (20 min.).
The PAT session can therefore be defined as "primary", scientific intervention's methodology of possible universal application.
It can also be hypothesized, for the effects of increase of intrapsychical communication, plasticity and efficiency of the brain-system, an integration in setting and models of interaction with mental functions of cognitive-behavioural, psychoanalytical and philosophical areas, so as an application finalized for obtaining a general improvement of the quality of life, because of the increase of mental and physical performances that can be obtained.

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