Enhancing the experience of soundscape through psychotropic sound design

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Abstract

This paper presents the possibility of counteracting a perceived general weakening of the listening sense, by applying 'psychotropic' sound design principles to composition. These principles draw on observations from the music therapy domain to enhance and promote the perception of natural acoustic ecologies as a contemplative 'deep listening' experience.

Vision

In parallel with the development of Acoustic Ecology perspectives, the recording and subsequent composition and diffusion of ambient soundscapes has matured as an art practice. The possibility of approaching a recorded soundscape with a contemplative listening attitude seems a natural extension of John Cage's suggestion that the finest musical experience is to be had 'just by sitting outside the front door and listening'. Digital reproduction technologies have made that possibility relatively easy to realise, and well we might harness them in pursuit of a deep listening practice, as they allow us to sit outside an endless variety of front doors, whenever and wherever we choose.

The fading power of soundscape—dissociation and the development of 'listening prejudice'

'Deep listening' faces real challenges in the 21st century. Not only does the city dweller have to deal with obvious affronts to her hearing sense such as ever-mounting traffic and industrial noise, but with more insidious noises as well. As Truax (since 1977) and others (e.g. Wrightson 2000) have deftly expounded, the mass-media model of communication co-opts and polarises listening reactions for mercantile ends, reducing listening to a one-way process of passive *consumption*. One unfortunate response to the encroachment of such forces into deep psychophysical space is conscious (or more often subconscious) dissociation from our own auditory sense. The deeply integrative immediacy of the child's open ear gives way to a more analytical perceptual tone. We come to treat the ear and the information it provides as a kind of cybernetic sensory extension, such that we can shut out at will those sounds which offend our sensibilities. When the signal-to-noise ratio falls below a critical threshold, such a defensive adaptation seems natural enough—to not develop perceptual selectivities this way is the fate of the autistic, and would leave us vulnerable to sensory overload.

However, the hidden cost of such a response is greater than we might imagine. Truax has written extensively on the soundscape's capacity to convey information (e.g. Truax 1984). Sound is ostensibly a deep 'mediator' between listener and environment. Yet, as we develop these defensive strategies against 'noise', we in effect become desensitised to sound. In the 'developed' world where, as Wrightson has noted, 'sound becomes something that the individual tries to block, rather than to hear,' many listeners have broken contact with sound's power as a deeply meaningful interface between them and their environment.

Thus these psychological strategies come to constrain our appreciation of soundscapes, both natural and composed. They express themselves

as *listening prejudices*—auditory desires and aversions—evolved from the felt need to isolate informational sound from 'merely impinging sound data', to demarcate a genuinely communicative listening space (with privileged access to a deeper level of perceptual engagement) from ever-encroaching 'noise'.

When it comes to dedicated music listening, one faces further 'listening prejudices' arising from music culture and training. For example, there is a mental space of 'concert-going,' arising from a shared sense of purpose—of gathering in a social event in a designated, special space. Listeners to a concert adopt an almost ritualistic physical posture—seated with their ears in an effectively fixed position, muting other channels of sensory stimulation by remaining still and perhaps closing their eyes. The socio-environmental ambience surrounding a concert allows a kind of spell to be cast—in a culture with an almost mystical reverence for creative and re-creative acts there is a touch of magic vested in public performance—which prejudices the perception of any musical happening. Furthermore, institutional musical training invariably promotes an analytical stance, where the 'practised listener' (the listener conversant with a particular musical syntax and versed in a shared canon) engages a complex and dynamic process of expectation and resolution. Paradoxically, this makes it an arguably harder task for the music student than the layman to 'just listen'.

This kind of prejudice is all the more evident in the so-called *acousmatic* environment (where encounter with recorded soundscape typically happen) where, as Truax has noted, we are restrained from interacting with sound sources. So restrained, the best we can do is to *judge* the sounds, in terms of their conformity to or departure from what we already know. With electronically-reproduced sound, we are at the mercy of an unseen hand, the sound composer's. Whilst Pythagoras' original intention was to liberate his *acousmata* from spurious perceptual distractions by creating a more focused listening interaction (*acousmatum* being the term used to designate a student of Pythagoras, who gave his lectures through a curtain hiding his visual presence), the inherent lack of control one has in the face of a loudspeaker and the one-way flow of communication can paradoxically foster a passive attitude in the listener (Truax 1997).

Soundscape as a shamanistic re-integrative practice

To be passive in the face of environmental sound runs counter to the evolutionary purposes of hearing, and denies the vast potential of listening as a wholly immersive, contemplative practice. There are however, other possible responses to the noisy soundscape.

Terry Riley, Steve Reich and others associated with minimalist trends of the latter half of the 20th century urged the exploration of listening as ritual or ceremony, engaging sound as an aide to meditation. Contemporary composer and 'Deep Listening' evangelist Pauline Oliveros' 1971 work *Sonic Meditations,* for example, was designed to guide the participant into new levels of listening by promoting the interplay between two models of information processing—focal *attention* and global *awareness* (Clemen 2002).

Oliveros' conception of *Deep Listening* goes beyond simply an approach to interacting with sound and musical objects, to form the basis of a wider contemplative practice that prizes equanimity in the face of all sound. A participant in one of Oliveros' retreats comments:

> I've found over time that I am able to listen and notice sounds much more without judging them as pleasant or unpleasant. I go into them. There's the piece of Pauline's where you listen to a sound until the sound becomes unrecognizable—ReCognition is the title—it's a wonderful practice for me. (Buzzarte 2002)

Deep Listening is a process of constructive adaptation of the auditory sense with the goal that all sound experiences be appreciated without judgement. In other words, Deep Listening practice aims to overcome listening prejudice. Crucially, in the Deep Listening practice equanimity is achieved not through dissociation from the auditory sense, but by emotional detachment from what particular sounds might represent.

Notions of shamanism—integration with the Soundscape

Sensitivities to particular sounds in local acoustic environments and our interactions with those sounds play a major role in the music that humans produce. Siberian shaman music is an archetypal example of music as a window onto acoustic ecology. Despite the difficulties in approaching and interpreting Siberian shaman music from a Western art practice perspective (Hodgkinson 1996), it is nonetheless readily apparent that shaman music performance echoes the actions and sounds of Siberian animals and nature. Of shaman performance, Hodgkinson concludes,

> [it] is a negotiation between voluntary and involuntary aspects of cognition. The most important element we [as Westerners] can draw from shaman culture is the very close connection made between the natural environment—considered as sound—and the inner states of a person's being. (Hodgkinson 1996, 59)

Shaman performance is a human expression of nature's characters—the shaman's paean is for greater affinity with our surroundings through creative interaction with nature's life-forms and environments. We are to listen to these to discover the world around us, to feel more at home in it, and to realise the interconnectedness of all living things (Tucker 1992). The shaman's use of sound is based on a simple but powerful idea, familiar to ecoacousticians: there is a primordial relationship between the natural acoustic environment and inner states of consciousness. In this way, partaking of shaman performance (one does not merely "observe" such a performance) can be seen as a meditation on the natural sound environment, part of a re-integrative ecological practice.

Some contemporary music entreats similar contemplation of the energies of urban environments. Contemporary experimental recording artists offer renderings in sound of ordinarily unseen and unheard phenomena—cyber-spatial elements such as data-flow around the Internet or electromagnetic field radiation. Mechanical noise environments re-emerge in popular music as the angular sounds of 'Industrial Music' and 'Intelligent Dance Music' genres—works such as *Autechre*'s 1995 release *tri repetae* (Autechre 1995) or the extreme noise pieces of Masami Akita (*Merzbow*). Artists within the 'stochastic music' movement of the 1950s, of whom Iannis Xenakis was a major exponent, were attempting something similar: to use sound to make the complex and esoteric 'space' of probability mathematics more accessible on an experiential level (Clemen 2002).

The challenge to soundscape composers wanting to pursue shamanistic ideals—to those wanting to evangelise the experience of natural soundscape and to promote their preservation—is this: because of increasingly pathological listening prejudice it may no longer be reasonable to expect soundscapes to convincingly speak for themselves. It is rare to find listeners who are ready to listen in a neutral way. The task is harder for the 'western' soundscape shaman because she does not have the benefit of a developed ritual language supporting her practice—the language of ritual is out-of-context and largely meaningless for many in the west. This is especially true of recorded sound because of the nature of the acousmatic environment—with its inherent 'schizophonia' (Schafer's term characterising the listening response to sampled sound as 'a nervous condition' (Schafer 1977) with an inherent tension between our hearing of a sound, and the determination of the sound's source).

One response to this challenge begins in an awareness of the physiological response to sound.

Physiological response to sound

At the physiological level, Roederer (1982) reports that emotional responses to sound arise through interplay between the cortex and limbic system, with the hypothalamus as mediator. He notes that the limbic system (which is involved in autonomic functions) unlike the cortex, does not process or encode information—it is hard-wired at birth and basically *reacts* to cortical activity. Simplifying, the autonomic nervous system comprises two antagonistic mechanisms. The *sympathetic* nervous system effects arousal of the autonomic functions. The *parasympathetic* nervous system, which is a

trophotropic mechanism responsible for inhibiting activity of the sympathetic nervous system (producing behavioural patterns that conserve and restore energy, a decreased sensitivity to external stimulus, and sedation) (Anderson 1982, Fisher 1971).

Sounds designed to attract attention and elicit action, such as alarms, call upon the hard-wired patterns encoded in the limbic system to 'shock' the nervous system into a state of alertness, using high frequencies, at high intensity—sound vectors bearing ancient associations with proximate threat. Alarm sounds provoke the sympathetic nervous system to educe the *fight-or-flight response*. Conversely, music designed for meditation and stress-relief makes functional use of deeply seated affinities for heartbeat- and breath-like *spectromorphologies* (Denis Smalley's term to represent the dynamic shaping of the pitch-spectrum of a sound) to activate the parasympathetic nervous system and induce the *relaxation response*. This is the intention guiding all relaxation training modalities (Wolpe 1958). Significantly, because these 'global' states ('fightful', 'flightful', relaxed) determine perceptual priorities, our sensitivity to and propensity to further *process* these perceptions (by gearing in to higher-order analytic thinking) changes the deeper we engage them. In other words, how we perceive and react to sounds depends greatly on our prevailing 'bedrock' mental state—whether we are in a 'fightful', 'flightful', relaxed or other state-of-mind.

Developing an idea of 'psychotropic sound design'

We can thus begin to address listening prejudices with an experimental orientation to compositional thinking. This includes the notion of 'preparing an audience for audition' by eliciting changes in the way they listen—changes in their prevailing bedrock brain state.

The psychotropic orientation to soundscape recognises hearing itself as the basis for all encounters with sound, and recognises that the character of a listener's listening changes with mood and mental state. Rather than simply assume that a 'neutral' listening posture is available to all listeners (as contemporary academic acousmatic composers, following Pierre Schaeffer, have tended to), psychotropic sounds seek to re-orient the listener's perceptual priorities *using sound itself*, that the listener might transcend functional or analytical modes of listening.

Exploring the psychotropic sound matrix

The elements of a sound matrix composed with these principles form a model of the mind or a potential state-of-mind of the listener in her environment using frequencies normally beyond the range of human hearing, and seek to *entrain* the listener to that model. Employing knowledge of auditory processes gleaned from observations in biofeedback studies of altered perception and sleep research, audio therapists have isolated specific qualities of the psycho-acoustic interface with the potential to catalyse meditative states of awareness.

Psychotropic principles center around sonic mimesis of brainstates. The major dimensions in the psychotropic sound matrix are:

a. entrainment via *binaural beats;*
b. 'spectral activation';
c. noise.

The concept of entrainment is elaborated below. (Space limitations prohibit a detailed examination of *Spectral Activation* and *Noise* in the context of this article. Interested readers please contact the author.)

Entrainment via binaural beats

The term *entrainment* is employed in research across disciplines as varied as music, physics, engineering and neurophysiology. To become 'entrained', in the most general sense, means to resonate in sympathy with an external stimulus. In the sound world, to be entrained means to resonate in sympathy with a standing wave. If a 440Hz tuning fork is struck it will start to oscillate. Another tuning fork (of the same tuning) placed in proximity, will start to oscillate in sympathy.

The physics of entrainment can also be observed in bio-physical systems. *Audio Brainwave Entrainment* (ABE) refers to the capacity, or

feature, of the human brain to 'engage' various brainwave resonances at the suggestion of external aural stimuli (and to access their correlate states of awareness, as explained below). The brain exhibits a similar response as the second tuning fork in the above example, when stimulated by certain low frequencies.

These low frequencies can induce and sustain altered states of awareness. The states of greatest interest to ABE researchers and psychotropic composers alike are those states variously referred to as meditative, trance, altered, hypnagogic, hypnotic, and twilight-learning states (Budzynski 1986). Mavromatis found that these various forms of consciousness rest on the maintenance of awareness within the context of a physiologically reduced state of arousal marked by parasympathetic dominance (Mavromatis 1991).

The frequency range from 0-30Hz is the critical band to entrain the brain to these states. Different states of awareness have been correlated with dominant (*long-term coherent*) brainwave frequencies in this band, as recorded on an *Electroencephalograph* (EEG) (Atwater 1997a). It would be grossly inaccurate to equate the brain's electro-neurological activity with consciousness itself, and Rosenboom (1997) has noted the arbitrary nature of EEG range divisions, but the EEG continues nonetheless to be a reliable way for researchers to estimate states of consciousness based on the relative dominance of frequency patterns.

However, the frequencies 0-30Hz extend below the range of typical human hearing. Therefore simply reproducing the frequencies directly in ambient sound would not appear to produce the required stimulus—the required frequencies cannot be 'heard' in the traditional sense. It is instead necessary to induce a frequency stimulus in the brain itself, by applying knowledge of the psycho-acoustic phenomenon of 'beating'. A 'virtual' sound waveform can be set-up in the post-ear part of the auditory system. The sensation of binaural beating occurs when two coherent sounds of nearly similar frequencies, for example a 440Hz tone and a 448Hz tone, are presented one to each ear with stereo headphones. The brain integrates the two signals producing (or rather *synthesising*) the sensation of the interferential difference tone, i.e. 8Hz. This third sound is known as the binaural beat.

Entrainment via binaural beats has been researched as a consciousness management technique, by designing audio environments to entrain a specific bedrock rhythm in the cortex. Binaural beats have been used in various therapeutic scenarios. Atwater (1997a) reports that binaural beats in the delta (0.5 to 3Hz) and theta (4 to 7Hz) ranges have been associated with the induction of relaxed, meditative and creative states (Hiew 1995), sensory integration (Morris 1990), and used as an aid to falling asleep (Wilson 1990; Rhodes 1993); that low frequency binaural beats applied in combination with cognitive therapy have been successful in treating alcoholic patients (Waldkoetter & Sanders 1997); that binaural beats in the alpha frequencies (8 to 12Hz) have increased alpha brainwaves (Foster 1990); and that binaural beats in the beta frequencies (typically 15 to 35Hz) have been associated with reports of increased concentration or alertness (Monroe 1985), improved memory (Kennerly 1994), and increases in focused attention in mentally retarded adults (Guilfoyle & Carbone 1996).

Early researchers in the field hypothesised a Newtonian entrainment process, but that has since given way to a focus on the functions of the *Extended Reticulated Thalamic Activating System* (ERTAS). Atwater explains that the word 'reticular' means net-like and the neural reticular formation itself is a large, net-like diffuse area of the brainstem. The ERTAS controls attention and awareness—the elements of consciousness itself—by stimulating the thalamus and cortex, controlling general level of arousal (Atwater 1999). This determines a 'bedrock' state of the brain, and influences how we interpret, respond, and react to information. This 'information' encompasses the whole range of stimuli present to the system, including internal stimuli and responses-in-progress, feelings, attitudes and beliefs as well as external sensory stimuli.

Under this model, binaural beats are thought to influence consciousness by providing information suggestive of a particular bedrock brain state (attentive, relaxed, etc.) to the ERTAS. For effective entrainment, this information must be presented in a form analogous to the reticular formation's own wave

patterns. *Homeostasis* describes the dynamic equilibrium of bodily functions. To maintain homeostasis the ERTAS actively monitors and continues the cortical replication of ongoing brainwave states (unless, of course, there is reason to make an adjustment due to new information from internal sources or external sensory input) (Atwater 1999). In other words, one of the inputs to the feedback process responsible for maintaining the homeostatic 'bedrock' brainstate is the bedrock waveform itself.

Essentially, if binaural beat techniques work for a given individual in the therapy context, they work by 'masquerading' as this feedback stimulus. Atwater explains:

> Because of the natural brainwave-like characteristics and persistence of the Hemi-Sync [a patented entrainment system based around binaural beat technology] sound field, the [ERTAS] initiates cortical replication of the Hemi-Sync stimulus, believing the Hemi-Sync pattern to be the ongoing brainwave state. As time passes, the [ERTAS] monitors both the internal and external environment and the state of consciousness itself to determine, from moment to moment, its suitability for dealing with existing conditions. As long as no conflicts develop, the [ERTAS] naturally continues aligning the character, quality and traits of consciousness with the information in the brainwave-like pattern of the Hemi-Sync sound. (Atwater 1999)

Thus recordings for therapeutic purposes are composed as a model in sound of a particular brainstate (or at least characteristic traits of that state). That is, a brainstate proposed to aid in healing or alleviating the symptoms of the presenting patient.

Auditory entrainment has its limitations. Binaural beats are subtle signals. Strong environmental stimuli will invariably override them to determine the ongoing state of the organism—even binaural beats cannot relax a person in the midst of a major environmental, emotional or physical upheaval. But if internal stimuli, emotional states, and environmental stimuli are not in significant conflict with the bedrock state suggested by the sound signals, the ERTAS will tend toward matching the binaural beat stimulus as a natural function of maintaining homeostasis.

In any case, the ultimate effectiveness of such techniques for the treatment of specific disorders (despite the growing body of research) is not at issue here. The present concern is rather to appropriate these purportedly powerful sound vectors in the service of an experimental aesthetic orientation.

Conclusion: entraining 'open listening' with binaural beat matrices

Listening repeatedly to entrainment matrices involves entering into a relationship with sound reminiscent of the *biofeedback* paradigm. Contrary to early representations of biofeedback as an extension of a conscious control hierarchy over bodily processes, it has been demonstrated (for example by (Jantsch 1980)) that in alpha wave production, control cannot be achieved with rational processes. As Rosenboom indicates, 'the subject must find a way to allow [alpha] wave production to evolve rather than make it appear' (Rosenboom 1997). This suggests the kind of 'open awareness' associated with meditative practices, which in the context of a listening practice becomes 'open listening'. The programmed binaural beats support open listening modes by encouraging the successive relaxation of other brainwaves associated with analytical listening modes.

Binaural beats afford an intriguing aesthetic opportunity: to explore in sound design frequencies that are ordinarily below the threshold of human auditory response—frequencies that seem to be otherwise reserved for the internal representation of arousal-level information in the Central Nervous System. There are various ways to incorporate binaural beat phase differentials in composition—they can be applied to distinct audio streams, or over a grouped multi-channel mix. Relationships between sets of differentials can act like 'infrasonic chords'. Phase differentials needn't be simple nor constant—composers such as Michael Hutchison have experimented with more complex (actual brainwave-derived) waveforms.

Such sound vectors should not be thought of as musical materials in any classic sense. They are instead a way to shape the 'listening mindset'

for subsequent listening experiences—an interferential matrix subtly convolving the featured soundscape to aid deeper listening. Entraining the brain *trophotropically* (to lower levels of cortical arousal) can disentangle maladaptive ways of hearing, and facilitate the natural processes of re-organisation and re-integration of the senses, enabling a deeper listening experience.

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