INAUDIBLE FREQUENCIES AND THERE EFFECT ON HUMANS BEINGS

First, infrasonic exposure may possibly have an adverse effect on human health (Danielsson and Landstrom 1985), suggesting that the biological sensitivity of human beings may not be parallel with the “conscious” audibility of air vibration.

Second, the natural environment, such as tropical rain forests, usually contains sounds that are extremely rich in HFCs over 100 kHz. From an anthropogenetic point of view, the sensory system of human beings exposed to a natural environment would stand a good chance of developing some physiological sensitivity to HFCs.

Therefore, it is premature to conclude that consciously inaudible high-frequency sounds have no effect on the physiological state of listeners.

positron emission tomography (PET)

high-frequency components (HFCs) above 22 kHz

low-frequency component (LFC) below 22 kHz

regional cerebral blood flow (rCBF)

electroencephalogram (alpha-EEG)

functional magnetic resonance imaging (fMRI)

fast Fourier transform (FFT)

analysis of variance (ANOVA)

protected least significant difference (PLSD)

brain electrical activity maps (BEAMs)

PET provides us with detailed spatial information on the neuroanatomical substrates of brain activity. Combining these two techniques with psychological assessments, we provide evidence herein that inaudible high-frequency sounds have a significant effect on humans.

It is widely known that the upper limit of the audible range of humans varies considerably. It usually corresponds to around 15 or 16 kHz in young adults and sometimes below 13 kHz in the elderly, and some people can recognize air vibrations of 20 kHz as sound.

Despite the fact that nonstationary HFCs were not perceived as sounds by themselves, we demonstrated that the presentation of sounds that contained a considerable amount of nonstationary HFCs (i.e., FRS) significantly enhanced the power of the spontaneous EEG activity of alpha range when compared with the same sound lacking HFCs (i.e., HCS). In parallel experiments employing exactly the same stimulus and methods, PET rCBF measurement revealed that FRS activated the deep-lying brain structures, including the brain stem and thalamus, compared with HCS. In addition, subjective evaluation by questionnaire revealed that FRS intensified the subjects' pleasure to a significantly greater extent than HCS did.

In contrast to the fact that the primary auditory cortex in the bilateral temporal lobes was similarly activated by FRS and HCS, it is noteworthy that the brain stem and thlamic foci activated by the presentation of FRS showed a decrease in rCBF when HCS was presented, as shown in Fig. #5.

This finding suggests that these areas may not belong to the conventional auditory perception system. Moreover, it is the combined presentation of HFCs and LFCs, not HFCs alone, that specifically induces the enhancement of alpha-EEG and activation in the deep-lying structures. We interpret these findings to mean that the hypersonic effect does not simply result from a neurophysiological response to isolated frequencies above an audible range, but from a more complex interaction to which HFCs and LFCs both contribute.

This modulatory interaction between inside and outside the classical auditory receptive range is noteworthy. However, we cannot conclude that the neural mechanisms incorporating ultrasound hearing, including the bone-conducting auditory pathway, are the system responsible for the hypersonic effect, which involves the brain stem and thalamus. These regions showed decreased activity compared with the baseline when HCS was presented and thus may not belong to the conventional auditory perception system. Therefore participation of nonauditory sensory systems such as somatosensory perception also needs to be considered in further investigations.

We pay special attention to the fact that FRS is accompanied by an intensification of the pleasure with which the sound is perceived, and envisage the participation of the neuronal pathways in connection with reward-generating systems (Cooper 1991; Olds and Milner 1954; Wise 1980), which effectively control various aspects of human behavior.

The brain stem contains distinct neuronal groups that are the major source of monoaminergic projections to various parts of the brain (Nieuwenhuys et al. 1988; Role and Kelly 1991). These monoaminergic systems are thought to be the primary sites for the action of many stimulants and antipsychotic drugs (Kandel 1991). The rCBF in this area was reported to increase after oral amphetamine challenge (Devous et al. 1995). These fibers lie in the medial forebrain bundle, which is considered to be intimately connected with registering pleasurable sensations (Thompson 1988). The monoaminergic neurons or the opioid-peptidergic neurons in the deep-lying brain structures are characterized by long neurotransmitter residence times at synaptic junctions and the participation of an intracellular messenger in the postsynaptic neurons (Hartzell 1981; Kehoe and Marty 1980; Schwartz and Kandel 1991). These characteristics seem to support the delay and persistence of the hypersonic effect observed in the present EEG experiments. The activation of the thalamus may reflect its function as part of the limbic system, which also plays an important role in the control of emotions (LeDoux 1993; Vogt and Gabriel 1993). It might also reflect the role of the thalamus in gating sensory input to the cortex (Andreasen et al. 1994). We speculate that changes of activity in the deep-lying structure may introduce some modulatory effects on the perception of audible sounds and thus control some aspects of human behavior.

The Mosquito or Mosquito alarm (marketed as the Beethoven in France, the Swiss-Mosquito in Switzerland and SonicScreen in the US and Canada) is an electronic device, used to deter loitering by young people, which emits a sound with a very high frequency. The newest version of the device, launched late in 2008, has two frequency settings, one of approximately 17.4 kHz that can generally be heard only by young people, and another at 8 kHz that can be heard by most people.

The maximum potential output sound pressure level is stated by the manufacturer to be 108 decibels (dB) The sound can typically only be heard by people below 25 years of age, as the ability to hear high frequencies deteriorates in humans with age (a phenomenon known as presbycusis).

The device is marketed as a safety and security tool for preventing youths from congregating in specific areas. As such, it is promoted to reduce anti-social behavior such as loitering, graffiti, vandalism, drug use, drug distribution, and violence. In the UK, over 3,000 have been sold, mainly for use outside shops and near transport hubs. The device is also sold in Australia, France, Denmark, Italy, Germany, Switzerland, Canada and the USA.