Excerpts on Tomatis from

THE THERAPEUTIC EFFECT OF HIGH-FREQUENCY AUDITION
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"Every sickness is a musical problem. The healing, therefore, is a musical resolution. The shorter the resolution, The greater is the musical talent of the doctor."

ABSTRACT:

"He that hath ears to hear, let him hear."
Matthew 11:15

This report presents a reinterpretation of the currently accepted theories of human audition. The anatomic structure and the neuro-physiologic function of the human ear are re-examined. A discussion of the theoretical underpinnings of an intriguing form of sound therapy, filtered high-frequency audition, is presented. The therapy itself is described as well as the patient population, which has benefited from this innovative approach over the past two decades.

INTRODUCTION:

"In all matters of opinion, our adversaries are deranged"
Twain

Through evaluating the controversies which rage within the field of neuro-audiology, it became quite clear that, in times of intellectual upheaval when one theory is attacked by another, qualities of courage and fidelity to scientific methodology are absolutely essential. Courage may be derived from a love of truth. Fidelity involves the ceaseless effort to concentrate, without bias or preconceptions, on the phenomenon itself. To perceive an object, without being waylaid into perception of one's concept thereof, is a profoundly challenging task. It is the keystone of a sound scientific edifice.

Therefore, when presented with interpretations which seemed far-fetched, it was an exercise in tolerance to reserve judgment until the case had been made in its entirety. An attitude of "reserve and observe" had to be cultivated. Only then, I found, can the data be appreciated from a new and exciting light. Children of convenience, we are often placated by the original interpretation of data and there it may sit atop its laurels, an incumbent theory, defying reinterpretation despite the advance of technology. In time, most theories yield to reformulation due to their inherent weaknesses in the face of persistent complexities. Few theories fit perfectly. However, this is never a peaceful process.

The radical reinterpretation of current thinking about the ear which is described below first caught my attention because of its clinical applicability as therapy.

THE ROLE OF THE HUMAN EAR

"A man clings all his days to what he received in his youth."
Paracelsus

Literature Summary:

Searching the literature, and taking degree of disagreement among specialists as my barometer, it quickly became apparent that the ear is a much studied, yet incompletely understood organ. What follows is a summary of the orthodox views regarding anatomy, neurophysiology and therapeutic potential of the ear. This information was gathered from my medical school basic science curriculum, a literature search and interviews with specialists in the field.

The human ear has two important functions: hearing with the cochlea and balance with the vestibule. The ear is routinely given short shrift in gross anatomy classes where its tiny intrinsic muscles such as the tensor tympani or the stapedius are rarely seen. In anatomy textbooks, the eighth cranial nerve, the acoustic nerve, routinely gets the least print.

Theoretically, the structural relationship and function of the ossicles involves sound, in the form of vibrational energy, which transverses the ossicles from tympanic membrane to oval window. The ossicles are, in order, the hammer (malleus), the anvil (incus) and the stirrup (stapes). The clinical significance of Rinne's and Webber's signs are presented as determinations of air and bone vibrations conducted to the oval window - the former by the ossicles, the later by the larger skull bones. Additionally, theory has it that this vibration is transmitted through endolymph in the superior segment of the spiraling cochlea (the vestibular ramp) up past high, middle and low frequency receptors (cells of Corti) to the apex of the spiral cupula before descending finally via the inferior segment of the cochlea (tympanic ramp) to the round window.

Among the orthodoxy, the only questions remaining are those regarding the processes which transform vibrational wave energy to electrical energy at the cells of Corti and ultimately to cognitive perception of recognizable sounds at the level of the cortex.

Comparison of Orthodox and Unorthodox Views:

1) Regarding the Embryological Origin of the Human Ear:

"If you want to understand what something is, you must look to see where it came from."
Goethe

Orthodox: It is commonly understood that the ear is divided into three parts - the external ear (meatus and canal), the middle ear (tympanic membrane, ossicles, middle ear muscles) and the inner ear (vestibule and cochlea).

Unorthodox: An appreciation of embryology suggests that there are, practically speaking, only two ears - an external and an internal ear. We know that the embryo originally consists of a series of five branchial arches [3]. The adult ear develops from the first two. More specifically, the first brachial arch will develop into the first two ossicles of the ear (the malleus with its muscle and the incus) and falls under the enervation of the trigeminal nerve (5th cranial nerve). The second brachial arch produces the third ossicle (stapes with its stapedius muscle) and is innervated by the facial nerve (7th cranial nerve). More can be made of the other organs which arise from these first two brachial arches (lower jaw with adductive muscles from the first and upper part of the larynx, the hyoid bone and the anterior ventral segment of the digastric muscle with opposes the jaw adductors) but references must suffice for interested readers [4]. My point here is that the ear is functionally understood as tripartite while actually comprising a polarity. This distinction becomes therapeutically significant in terms of high-frequency audition. (see following)

2) Sound transmission:

"We really ought to know by now how the ear works."
Ashmore in Nature 8/84

Orthodox: The commonly accepted role of the external canal as regarding sound transmission is considered to be a low-frequency filter. It is observed that bone vibrations of the skull can create sound waves in the external canal which excite the tympanic membrane [5]. The role of the ossicles is commonly understood as transmission linking sound vibrations at the tympanic membrane to the oval window [6]. The role of the middle ear muscles, the tensor tympani and the stapedius, according to von Bekesy, is to maintain the connection between ossicles. This long-standing interpretation is currently being challenged by Howell. The role of the endolymph is to further conduct the wave of kinetic energy towards its destination, the cells of Corti. The tectorial membrane's role is to anchor the hairs of the cells of Corti in order to facilitate the shearing force necessary to set up an active potential which will propagate along the eighth cranial nerve to the cortex for cognitive processing. The role of the cochlea is to contain the fluid and its kinetic force thus preserving the sound fidelity. the role of the round window is to dampen kinetic energy [7]

Unorthodox [4]:

A) The distance separating the incus and the stapes, sometimes up to 1 mm, and bridged by collagen, cannot conduct sound with fidelity commensurate with human hearing. To assume that high frequencies can be transmitted intact through this distance and medium seems unreasonable rather than transmitting vibratory energy from external to internal ear, the function of the ossicles is to dampen tympanic membrane vibratory energy via a kinetic negative feedback loop originating at hyperkinetic endolymph. This fluid force is transmitted to the base of the stapes then to the incus and finally to the malleus in order to diminish vibratory sensation headed to the ear. In effect, rather than transmitting sound, the ossicles serve a protective role by dampening excessive vibratory energy transmitted to compact bone at the tympanic sulcus. (Although the first, Tomatis is no longer alone in assigning a protective role to the middle ear. (Simmons 1964).

B) Endolymph is always moving [8]. Therefore, to consider that it can carry specific waves amidst the turbulence seems unreasonable. Additionally, the observation that sequential sounds can be transmitted almost instantaneously is inconsistent with the assertion that the sound is transmitted through the fluid [9]. The function of the endolymph as regards hearing is to buffer the shearing potential of the vibrational force. Here in the ear, as in other parts of the body (joints, brain vault), fluid does what fluid does best: its role as endolymph is to absorb kinetic energy and protect contingent structures from damage.

C) Removal of the ossicles in no way diminishes osseous conduction [5]. However, removal of the ossicles would result in a relatively flaccid contact between the tympanic membrane and the tympanic sulcus thereby accounting for the observed loss of 60db in air conduction.

D) Tomatis claims that osseous conduction (a highly controversial field at this time) is the major route of sound conduction to the inner ear. The route is as follows: air vibration hitting the tympanic membrane is spread outward along its radiating fibers to the tympanic sulcus where the petrous pyramid (compact bone) conducts the kinetic energy to the directly to the cochlea and finally to the basilar membrane [4]. A consideration of the anatomy of the tympanic membrane suggests that arciform fibers collect wave impulses and disperse them to the periphery of the membrane which is firmly attached to the sulcus. Opponents of bone conduction note that only direct contact of the vibration tuning fork to bone yields true fidelity and that the soft tissues atop the skull constitute resistance [5]. In light of that observation, it is interesting to note that the tympanic sulcus is the location where bone receives vibrational energy most directly. Furthermore, the endochondral capsule is the only place in the human body where primitive bone which developed from fetal cartilage persists unchanged (no resorption) from before birth until after death. Thus, this static medium is the ideal conductor for vibratory energy. (Whales hear via osseous conduction). The oval and round windows, like the eustachian tube, function as additional buffers against the shearing force requisite in audition. To function optimally, the human ear must maintain a micro-homeostasis which allows for maximal sensory perception with minimal shearing and destruction of hair cells. The role of the middle ear then is to guard the sensitive cells of Corti which are responsible for energy transduction within the inner ear.

E) Flock was not the first to observe that the basilar membrane vibrates. However, he was the first to announce the disruptive observation that hair cells, the organs of Corti, contain actin and a variety of protein associated with contractility [10]. Consequently, the suggestion arises that the cells of Corti are end organs rather than sensory cells imply that they play a role in cochlear mechanics. Therefore, where once we thought that the endolymph vibrates the basilar membrane, we now have data calling that into question. It remains solely a matter of interpretation as to whether the endolymphatic eddy is the cause of, or, as Tomatis suggests [4], the result of the resonating membrane.

F) The tiny stapedius muscle, which controls the stapes and thereby regulates high-frequency audition, is the only muscle of the human body which never rests [4]. Even the heart pulsates, a motion which involves periodicity and therefore a rest of sorts. The

stapedius, however, is constantly involved in regulating sound perception form the fourth month post-conception until the moment of death [11]. This constancy has significance as regards cortical charge (cf cortical charge).

3) Ear Neurology:

"The Nerves of the Terrible Pterygopalatine Traffic Circle"
every anatomy student's nightmare

The ear is the Rome of the body. As a student of gross anatomy, it struck me that almost all cranial nerves lead to the ear. Whether directly or anastomatically, the ear is involved with cranial nerves 2-11. The 5th and 7th cranial nerves innervate the ossicular muscles. But, in order to fully appreciate the extra-auditory and extra-gyratory role of the acoustic or eighth cranial nerve, we must understand the oculo-cephalo-gyre crossover which, in mammals showing a high degree of cortical sophistication, is apparently under the control of the visual function [4]. It is customary when dealing with cortical functions to link eye, head and neck mobility with the optic nerve. However, the coordinated interplay of these functional structures is under the control of the acoustic nerve. This structure, appropriately called the audio-opto-oculo-cephalo-gyro cross-over is the major mechanism of reception and integration of perception. Therefore, the ear is now understood to be neurologically involved with the optic or 2nd cranial nerve, the oculomotor or 3rd cranial nerve, the trochlear or 4th cranial nerve, the abducens or 6th cranial nerve and the spinal-accessory or 11th cranial nerve which is responsible for posterior-lateral musculature of the neck.

Not satisfied with this scope of neurological involvement, the ear has a fascinating tie into the 10th cranial nerve or the vagus, "path of the wandering soul." What has the vagus to do with the ear? For those of us who think of the tympanic membrane solely as a receiver for sound waves, i is instructive to recollect that a solitary cutaneous sensory antenna from the vagus presents on its outer surface and that its inner surface is sensitized by the vagus via an anastomosis with the glosso-pharyngeal or 9th cranial nerve. What is the significance of vagal and acoustic interaction? Let us track this path throughout the body. The vagus wanders on contacting next the postural back muscles via an anastomosis with the spino-accessory or 11th cranial nerve, then sensitizes that part of the larynx responsible for vocalization via the upper laryngeal nerve before delivering motor innervation via the recurrent laryngeal nerves. Subsequently, the vagus innervates the bronchi and heart before joining the opposing vagal nerve and diving through the diaphragm to innervate the entire viscera including the gastro-intestinal tract from esophagus to anus (via anastomosis with sacral nerves 2, 3, and 4).

The effect which audition has via the vagus is substantial. Prasad observed cardiac depression upon syringing the ear [12]. But this ought not surprise us. What would a scary movie be without the emotionally manipulative sound track? Think of the effect which a patient in the process of vomiting has on our own intestinal homeostasis. It is empathy, or perhaps direct vagal stimulation from our tympanic membrane to our gastrointestinal track which evokes our similar contraction. As the ear becomes appreciated as our primary sensory organ (for both internal and external phenomenon) as well as a vagally mediated

internal moderator via its extensive anastomotic innervations, a theoretical basis for audio-therapy comes into focus.

This is only a glimpse of some major reinterpretations of ear structure and function. The bibliography offers the reader opportunity to pursue these and other equally off-putting assertions in greater detail than the scope of this report justifies.

THE WORK OF DR. ALFRED A TOMATIS

"Creative imagination is frequently associated with the interplay between two conceptual frameworks."
Koestler

Born in 1920, Dr. Tomatis earned his M.D. from the Faculte de Paris before specializing in oto-rhino-laryngology. En route to establishing the International Association of audio-Psycho-Phonology, Dr. Tomatis was distinguished as follows: Chevalier de la Sante Publique (Knight of Public Health) 1951; Medaille d'Or de la Recherche Scientifique (Gold Medal for Scientific Research) 1958; Grande Medaille de Vermeil de la Ville de Paris 1962; Prix Clemence Isaure 1967, Medaille d'Or de la Societe Arts, Science et Lettres 1968; et Commandeur de Merite Culturel et Artistique 1970.

As a scientist, Tomatis is well recognized for his experimental breakthroughs in the field of auditory neurophysiology. For example, while treating hearing impaired factory workers by day, and scotoma-cursed opera singers by night, Tomatis noticed a similarity of symptoms between the two patient populations. After further investigation, he formulated the law describing the feedback loop between the larynx and the ear: "the larynx emits only the range that the ear controlled." In other words, one can reproduce vocally only those sounds which one can hear. This discovery was recognized by the Academy of Sciences of Paris and the French Academy of Medicine who, in 1957, announced the Tomatis Effect in honor of its discoverer.

As a clinician, Tomatis has achieved the reputation for successful and unorthodox therapies whose scope exceeded the scope of oto-rhino-laryngology. The list of maladies successfully treated via high-frequency auditive therapy includes: Ear, Nose and Throat disorders: (hearing and voice loss [13], stuttering [14], tinnitus [15], otitis media [15], scotomas [16, 17]); Neurological disorders: (toe walking from vestibular nuclei problems [18], drooling [15, 19], strabismus [15]); Psychiatric disorders: (depression [20], attention deficit disorder [21], hyperactivity [21]); and Learning disorders: (dyslexia [22], inability to concentrate [15]); and a variety of balance/coordination problems related to the ear's vestibular disorders [15]. These therapeutic coups occur via retraining the ear muscles using another Tomatis invention, the electronic ear (see below). These claims regarding the therapeutic efficacy of filtered sound was what drew me to France. What follows will be a brief description of the theoretical bases and practical applications of Tomatis's therapeutic work.

Electric Ear and Middle Ear Micro-gymnastics:

"This machine trains athletes of the middle ear - it produces champion listeners."
Tomatis

Theory: Most of us have fiddled with the bass/treble knob on a stereo set. What we probably did not recognize, however, was that it was easier to hear the bass sounds than it was the treble ones. (Bass being closer to touch on the continuum of sensible vibratory energy, that is, hearing as tactile reception is a form of touch). This difference in relative ease of listening became the crux of Dr. Tomatis's electronic ear. This machine is designed to help the ear acquire three functions: listening, monitoring of language and laterality.

The electronic ear works by delivering to the listener's ear a course of sound which is progressively filtered along a continuum from normal non-filtered sound to sound where all save frequencies greater than 8000 hz have been filtered away. In addition, the sound delivered to the patient alternates between two channels which are set at maximum bass and maximum treble. Consequently, the stapedius muscle must control the stapes in order to listen to ascending high-frequency sounds as well as accommodate the fluctuations between bass and treble at the given frequency. This challenge to the atrophied middle ear muscles (especially the stapedius muscle of the stapes which is primarily responsible for high-frequency discrimination) constitutes the micro-gymnastics, which orchestrate the reattainment of physiologic listening or focusing function of the ear.

Application: Auditory disorders are easily identified by noticing aberrations from normal listening posture (note monastic posture of head inclined at 30 degrees which levels the horizontal semi-circular canal), atonality or lifeless speech, poor body tonus, substandard motor coordination, facial dyskinesias and lateralization to the left (talking out of left side of mouth). Predictors of auditory disorders involving high frequencies would include dyslexics, stutterers (i.e. a variety of learning disabled people) as well as products of traumatic births (caesarian sections, premature, forceps-damaged, and anoxic as well as occasional twin births) [24].

Tomatis is given credit for being the first to appreciate the important neuro-physiological distinction between hearing and listening. The former is non-selective, whereas the latter is a focusing of the ears and an attending to one of the many sounds that are heard simultaneously. Hearing is less strenuous than listening, which involves will power. Tomatis's listening test differs from the audiogram of the audiologist in that the listening test is concerned not only with organic capacities of the ear, but also with the degree to which the ear's potential is being utilized by the patient. An audiologist will frustratingly acknowledge that many people that come to them with hearing problems who, according to their audiograms, can hear perfectly well. In fact, their problem is not with hearing, but with listening. A course of therapy with the electric ear has been shown to improve these listening problems as measured by reattainment of optimum air and bone conduction curves on a standard audiogram.

Equally exciting is the ability of geriatric patients with high-frequency hearing loss to attain partial or complete recovery of their optimum audiometric curves. In fact, Tomatis has

demonstrated therapeutic successes in all types of hearing loss cases save sensorineural loss as measured by standard audiographic analysis.

Laterality:

"My left hand hath laid the foundations of the earth
and my right hand hath spanned the heavens."
Isaiah 48:13

Theory: Who can explain the phenomenon of asymmetry in our nervous system? No one yet. Who can offer insight into its significance? Tomatis's work on laterality as a consequence of this asymmetry is compelling. Aside from the stapedial workout designed to aid the reattainment of high-frequency audition, Tomatis's electric ear trains the right ear to be the dominant or leading ear. The basis for this dextrophilia is an understanding of the asymmetrical auditory pathways [25]. According to Tomatis, the left hemisphere's speech center (Broca) is most directly connected with the right ear [4]. Furthermore, the right recurrent laryngeal nerve (connected via the right vagus to the right ear), in looping under the right subclavian artery, constitutes a significantly shorter pathway than that of the left recurrent laryngeal nerve which loops under the aorta. Consequently, significantly longer auditory feedback loop exists on the left compared to the right side of the body. Furthermore, an individual with a dominant left ear must process auditory information over a significantly longer transcerebral auditory pathways (left ear to right auditory center to left auditory center to organs of speech = 70-140 m) than is required by a right dominant listener (right ear to left auditory center to organs of speech = 30-60 cm) [15,26].

Application: The process of lateralization to the right, achieved through the delivery of sound increasingly to the right ear, has the effect of facilitating and accelerating the - patient's processing of sensory and cognitive information [4].

This lateralization is an essential aspect of the therapeutic ear training which has proven valuable to the variety of patients listed above.

Sonic Rebirth and Uterine Hearing:

"… Hence, in a season of calm weather,
Through inland far we be,
Our souls have sight of that immortal sea
Which brought us hither.
Can in a moment travel thither.
And see the children sport upon the shore,
And hear the mighty waters rolling evermore"
Wordsworth
from "Imitations of Immortality"

Theory: Perhaps Tomatis's most provocative theory involves the idea of fetal audition [27]. Today, thirty years after Tomatis postulated this phenomenon, investigation of fetal

audition is in vogue. However, despite a rash of recent studies, it remains solely a matter of speculation whether, and if so, what the fetus hears. We know that the acoustic nerve is fully myelinated and functioning at 4.5 months post-conception [15] and we also know that the fetal eustachian tube is patent thereby permitting contact to the inner ear via embryonic fluid [4]. Tomatis suggests that the fetus hears the maternal heart and respiration as well as her intestinal gurgling. This, he postulates, comprises a constant background noise. It is important as cortical charge (see below) and may be the source of our collective attraction to the sound of surf or of our inborn sense of rhythm. The fetus would hear this biological noise, but to what would it listen? What is the only sound which comes and goes at irregular intervals? The voice of the mother. According to Tomatis, only the voice of the mother can penetrate via her bones (see osseous conduction) to the intrauterine world. The child's attention is fixed on this irregular sound which may serve as the fetus's first target of communication. Studies show that the newborn responds preferentially to the voice of the mother [28]. Pediatricians have observed that the newborn demonstrates preference for the mother's voice [28]. What is a reasonable explanation for this observation? Intrauterine hearing is a possibility.

Applications: The practical application of this theory are intriguing. By taking a uterine and birth history of a person with an auditory disorder, the therapist is able to predict a very curious event. Certain sound frequencies corresponding to intrauterine audition will evoke unpleasant sensations in adult listeners whose mothers experienced trauma at a certain gestational period. Additionally, a variety of neuroses are ameliorated simply by following a course called sonic rebirth. This involves, in part, the passage from audition through a simulated liquid element to audition through an atmospheric element. The mother's voice is recorded (often reading a child's story) and presented to the patient over a period of weeks progressively filtered from 8000 hz to 100 hz thereby simulating the auditory experience of uterine existence, labor, birth and reunion, this time via atmospheric conduction, with the maternal voice while nestled in the mother's arms. Freud's psychoanalytic theories and practice were once considered equally bizarre. Unlike Freud's cases, however, the patients of Tomatis who undergo sonic rebirth are objectively evaluated both behaviorally and using audiograms which assume a motivational and cooperative component.

One fascinating spin-off of the sonic rebirth is its application in learning a foreign language. For example, a businessman who wants to learn Arabic before being transferred to that country would undergo a sonic rebirth while listening to a course of filtered Arabic. In this way, his ears are progressively sensitized to the idiosyncratic sounds of that language. Without his ears being able to distinguish particular sounds, certainly his tongue would not be able to pronounce these sounds (remember the Tomatis Effect). In this manner, Tomatis has had extraordinary success giving people a new "mother tongue" in a language of their choice [29].

Primacy of the Ear:

"The ear builds, organizes and nourishes the nervous system."
Tomatis [15]

Theory: Tomatis asserts that the brain receives more stimuli via the ears than from any other organ. He considers skin to be differentiated ear rather than visa versa. In his two volume work, Towards a Human Listening, [4], he builds an intriguing defense of this radical departure from orthodoxy which involves, for example, phylogenetic data suggesting, paradoxically, that the ear preceded the nervous system. Furthermore, an impressive case is made suggesting that our sense corpuscles (Meissners, Pacinian, Krause, Merkel's) are differentiated organs of Corti. (See Flock et al [10] re recent confusion regarding the nature of the organ of Corti). Whether one emerges from a review of Tomatis's "Towards a Human Listening" surprised or not, certainly one gains an appreciation of the hitherto underrated role of the ear.

Application: An understanding of the idiosyncratic physiological aspects of the human ear has important therapeutic applications. Tinnitus, for example, is a debilitating hearing disorder whose etiology is undetermined and whose treatment (masking) is inadequate [28]. Tomatis asserts that tinnitus results from a swollen inner ear artery against which sympathomimetic drugs are ineffective. This is so, he explains, because of all the arteries in the human body, this artery is not under sympathetic control [15]. Tinnitus is only one of many problematic maladies which Tomatis treats successfully using an appreciation of the peculiarities of the human ear and a course of high-frequency auditive therapy via his invention, the electronic ear.

Cortical Charge:

"There are sounds which are as good a pick-me-up as two cups of coffee."
Tomatis [15]

Theory: The most exciting theory of Tomatis, and the one which led me to consider the role of sacred music as therapy, is the concept of cortical charge. Experience tells us that some sounds put us to sleep (lullabies) and some keep us awake (traffic); some calm us down (surf on the beach) and some make us dance all night (rhythm). A hard driving beat practically forces us to tap our feet. The screech of chalk on blackboard makes us scream and contract in discomfort. We are constantly bathed by sound and Tomatis has devoted his career to analyzing the effect which various components of sound exert on our physiology. The claim that music exerts a profound effect on us is beyond question. What remains is only to establish the correlations, perhaps psychosomatic, perhaps vagally innervated, of these sound components to our physiology. Let us listen to Dr. Tomatis directly. In a lecture before the International Kodaly Symposium in Paris, 1978, he describes cortical charge as follows:

> The ear is primarily an apparatus intended to provide a cortical charge in terms of electric potential. In fact, sound is transformed into nervous influx by the coliform cells of the cochlear-vestibular apparatus. The charge of energy obtained from the influx of nervous impulses reaches the cortex, which then distributes it throughout the body toning up the whole system and imparting greater dynamism to the human being.

All sounds cannot affect this process of charging. I pointed out that on the basilar membrane the ciliform cells of Corti are much more densely packed in the part reserved for the perception of high frequencies than in the one where the low frequencies are distributed; so that the transmission of energy that is caught up towards the cortex is much more intense when it comes from the zone of the high frequencies than when it comes from the part reserved for the low frequencies.

Thus the high sounds supply a more concentrated nervous influx and thus increase the effect of charging. This is the reason why I called the sounds rich in high harmonics the "charging sounds," in opposition to the low sounds or "discharging sounds." These low sounds supply insufficient energy to the cortex, which may even exhaust the individual, so much that they conduct corporal motor responses which actually, in themselves, absorb more energy than the labyrinth can furnish. The implication of this fact at the psycho-dynamic level explains that a depressed person tends to direct his hearing more intensively towards low frequencies which are the sonic range of visceral life: she actually becomes more aware of the noise of her breathing, of her heartbeat, and so on. It seems as if her ear has lost its ability to be used as an "antenna" for communication; instead, it is directed to the inside life.

The aim will be to provoke, with sonic training made of high-frequencies heard in a listening posture, this cortical charge to energize the individual. The effect of the training generally manifest themselves in the following ways to the greater subject:

-greater motivation and competence in working
-lower susceptibility to fatigue
-awareness of dynamism
-better possibilities of attention and concentration
-better memorization

Application: Anecdotal evidence suggests that certain high-frequency sounds confer alertness and stamina to the listener thereby enhancing performance. For example, students report that listening to Gregorian chant or classical music increases their ability to concentrate. If this modus operandi sounds strange to the reader, consider the time honored prescription "whistle while you work." Or try to imagine a military marching band without the fife. Granted the drums would discourage any waltzing by enforcing the left-right-left-right, but without the fife producing a cortical charge, how great would one's endurance be? Bugles, bagpipes…always the high-frequency tones are found en route to battle. Perhaps these shrill high-frequency tones impart an enthusiasm via neurophysiologically mediated cortical charge.

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