Early Effects of the Tomatis Listening Method in Children with Attention Deficit

A clinical dissertation

presented to the Graduate Faculty of Antioch University Seattle

as partial fulfillment of the requirements

for the Degree

Doctor in Psychology

By

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I certify that I have read this manuscript and that, in my judgment, it is fully adequate in scope and quality as a dissertation for the degree of Doctor in Psychology.

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An Abstract of

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This study investigated the early effects of the Tomatis Method, hypothesizing improvement in processing speed, phonological awareness, reading efficiency, attention, behavior and brain physiology by the end of Phase 1 of the Tomatis Method. This study documented the effects of the first phase of the Tomatis Method on children with ADD ages 7-13. Of the 25 participants, 15 received solely the Tomatis treatment while 10 served as controls and were stabilized on ADD medication three months prior to and throughout the study. Therefore, this research study compared Tomatis versus non-Tomatis intervention, not ADD medication treatment with Tomatis intervention. The Tomatis group received 15 consecutive 2 hour sessions; participants received no additional vestibular or visual-motor exercises throughout the research. Results revealed statistically significant improvements for the Tomatis when compared to the non-Tomatis group: the experimental group showed significant improvement in processing speed, phonological awareness, phonemic decoding efficiency when reading, behavior, and auditory attention. A statistically significant increase in slow brain activity at central and parietal midline recording sites in the Tomatis group was observed when comparing pre- and posttreatment theta/beta ratios within each group. Taken in isolation, these are paradoxical findings as they do not concur with the gains documented. The peak alpha

frequency values and the *z*-scored theta/beta ratios of the pre- and post- qEEGs for each participant in the Tomatis group were further explored. The paradoxical increase in theta/betha ratios obtained from individual raw values were not observed to the same extent when using z-scores. The *z*-scores suggested that the theta/beta ratio, although higher for the Tomatis group after training, remains within the average range for all participants. The individual analysis showed that the changes observed still fell within normal values, which may serve to explain the behavioral gains. To conclude, the significant improvements noted in cognition, attention and behavior, strongly suggest that the Tomatis Method has positive effects in children with ADD. These early changes in brain physiology require further research. This dissertation is accompanied by a supplemental qEEG reports file in PDF format. The electronic version of this dissertation is available through the OhioLink ETD Center, www.ohiolink.edu/etd.

Dedication

To my parents, Elena and Eugeniu Sacarin, and my brothers, Cristinel and Gabriel Sacarin who supported me throughout these years; to Bruce Haley, who fully stood by my side from the application through the proposal part of my doctoral study.

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Individual_qEEG_Reports.pdf PDF 44,635kb

List of Abbreviations

ADD	Attention Deficit Disorder
ADHD	Attention Deficit Hyperactivity Disorder
APP	Audio-psycho-phonology
ASD	Autism Spectrum Disorder
BASC-II	The Behavior Assessment System for Children – Second Edition
CD	Coding Subtest
CI	Confidence Interval
CPT	Continuous Performance Test
CTOPP	Comprehensive Test of Phonological Processing
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition
EEG	Electroencephalography
ERP	Event Related Potentials
EO	Eyes open
$f0$	Fundamental frequency
FFR	Frequency following response
FFT	Fast Fourier Transformation
fMRI	Functional Magnetic Resonance Imaging
IVA-Plus	Integrated Visual and Auditory Continuous Performance Test
LR	Linear Regressions
MEG	Magneto Encephalography
MSRD	Monroe Sherman Reading Diagnostic
N200	Negative Wave 200 Milliseconds
PACS	Phonological awareness composite score
P300	Positive Wave 300 Milliseconds
PRS	Parent Rating Scale
PDD	Pervasive Developmental Delay
PDE	Phonemic decoding efficiency
PIC	Personality Inventory for Children
qEEG	Quantitative Electro-Encephalogram
SWE	Sight word efficiency
SAE	Standard American English
TOWRE	Test of Word Reading Efficiency
TLT	Tomatis Listening Test
TOVA-A	Test of Variables of Attention- Auditory
VEP	Visual evoked potentials (VEP)
WISC-IV	Wechsler Intelligence Scale for Children – Fourth Edition
WISC-R	Wechsler Intelligence Scale for Children-Revised
WRAT	Wide Range Achievement Test

Chapter I Introduction

The Tomatis Method of Sound Stimulation

Training of the human auditory system through music and sound as an educational activity seems intuitive and is historically widely accepted. What has been less obvious is that in addition to auditory processing, other neural systems can be affected by musical experiences and sound stimulation training. Recent neuroscience research suggests that sound and music stimulation have positive effects on cognitive functions such as attention, memory, learning, and language development (Patel, 2006). These findings open a different perspective on human peak-performance training, and more importantly, on therapeutic applications of sound and music stimulation for individuals who present attention, learning, motor and language development challenges.

Kraus and Banai (2007) have also shown that broader cognitive functions beyond language development are strongly related to auditory processing, which is a response to our sound milieu. According to these researchers, the auditory system is involved in complex physiological interactions across both cortical and subcortical anatomical areas; this involvement suggests that auditory processing is dynamic, and influences higher cognitive functioning such as attention, memory, and contextual framework, while at the same time being influenced by these cognitive functions. Very early and long-term experiences with one's mother tongue shapes both speech perception and one's auditory processing capabilities (Fais, Kajikawa, Amano, & Werker, 2009; Kuhl, 1979; Liu, Tsao, & Kuhl, 2009; Rivera-Gaxiola, Silva-Preyra, & Kuhl, 2005). The same is true for early and long-term musical or sound stimulation training (Kraus & Banai, 2007).

The world's first and most widely used method of sound stimulation was developed by the French ear nose and throat physician and surgeon Alfred Tomatis in the 1950s. Tomatis tirelessly perfected his method and technology until his death in 2001. A prolific author, he published 11 books and numerous articles on his theories, clinical experience, and research findings. However, although the Tomatis Method spans a half century of successful clinical testimony in 250 centers around the world, there still exists insufficient experimental research to clearly identify its effects on the brain's physiology, cognition, language, sensory-motor processing, and behavior.

The Tomatis Method of sound stimulation uses Mozart, Gregorian Chant, Strauss waltzes, the mother's voice, and children's songs in its initial (passive) phase of training, and one's own voice in the later (active) phase of the program. The Tomatis Method uses the Electronic Ear, a device as originally developed by Alfred Tomatis that provides filtered, gated and timed sound stimulation via headphones and the subject's cranial bone conductors. The sound is contoured such that when it drops in amplitude below a certain level, low frequencies are amplified while mid- and high-range frequencies are filtered out. This occurs on Channel One of the Electronic Ear. When the amplitude rises just above this set point, the opposite occurs: lows are removed while the rest of the frequency spectrum is amplified. This occurs on Channel Two. The gating pivot filter of 1000 Hz was fixed in the original Electronic Ear. In addition to the described sound gating that occurs on these two parallel channels, the Electronic Ear contains timing mechanisms between the bone and the air output of sound. The timing mechanism encompasses delay and precession timing, which together with the gating controls the delivery of sound in an interchangeable form between the air and the bone. More precisely, when the gate switches from Channel One to Channel Two, the bone conduction output is switched to first in time for a pre-determined period. This means the listener first experiences the switch of the bone conduction from one channel to the other. Thus, the bone hearing precedes the air conduction or headphones switch from Channel One to Channel Two. The switch of the air conduction from Channel One to Channel Two occurs only milliseconds later and is part of training the mid-ear and the brain to perceive mid-range and higher frequencies with improved accuracy. The described timing mechanism is called *precession*. In addition, there is a timing mechanism called *delay*. This means that the bone conduction is the last one to be perceived when switching occurs back from Channel Two to Channel One. The delay and precession timing can be individualized for each person. In the newest Electronic Ear models, gating pivot filters are also adjustable; such a model was used in this research.

For Tomatis, the training of the listening function was the central piece when optimizing learning including language, speech and voice processing, coordination and rhythm. He pointed out that the ear's function stretches far beyond listening, which he considered a voluntary, active act and distinct from hearing (Sollier, 2005). Tomatis (1974) described three integration levels in his neurophysiologic model of the ear-brain connection: the vestibular, visual and cochlear integrators. He pointed out that the second (optic) cranial nerve, the third (oculomotor), the fourth (trochlear), the sixth (abducens) and the eleventh (accessory) connect with the eighth (vestibular cochlear) nerve, participating in reception and integration of information from the ear and other sensory systems (Tomatis, 1974).

The vestibular integrator regulates the sense of balance and therefore the muscle tone regulation in the body and is the foundation for good motor coordination. The vestibular system situated in the internal ear transmits information to the brainstem through the vestibular subdivision of the eighth cranial nerve. The afferent connections between the hair cells in the semicircular canals of the vestibular system with the vestibular nuclei in the rostral medulla and caudal pons can be stimulated and trained with sound. Due to the Tomatis sound training, functions such as balance, muscle tone regulation, and coordination, to name a few, are meant to be positively affected (Solier, 2005).

Tomatis (1974) referred to the visual integrator as the neurophysiological process through which information from the ear and the eyes is integrated, leading to human visual and spatial perception. For instance, specific pathways connect the vestibular nuclei with the sixth and the fourth cranial nerves and the oculomotor nuclei participating in the vestibulo-ocular reflex. The internal ear is involved through this and other neurophysiological mechanisms in the functioning of the eye. Eye movements such as fixating on an object, tracking while the body is stationary (such as when one is reading), or tracking while moving the body at the same time (such when walking and reading a sign) are not realizable without integrating undistorted information from the internal ear. When training with the Tomatis Method, visual perception and visual-motor functioning are assumed to be positively affected once the vestibular function and muscle tone regulation are improved (Sollier, 2005).

Tomatis (1974) pointed out that connections between the reticular formation and the vestibular nuclei regulate attention and arousal; thus, attention is meant to improve when using the Tomatis Method of sound stimulation (Sollier, 2005).

The cochlear integrator consists of connections between the ear and the brain affecting speech, language learning and processing, including voice control. Sound reaches the brain from the cochlea via the eighth cranial nerve and the geniculate body of the thalamus, projecting ultimately into the auditory primary cortex. Tomatis (1974) elevated the importance of the thalamus in understanding the ear-brain connection and the feed-forward, feed-back mechanisms involved in this complex neural system. The relay nuclei in the thalamus relate information from the ear to the cortex. Similarly, efferent pathways from the cortex relate information back to the thalamus and then to the ear and voice control mechanisms (Tomatis, 1974). Besides improving listening, i.e. attending to and processing spoken language, the Tomatis Method is meant to improve speech and singing ability, in addition to processing language when reading (Sollier, 2005). Having trained with Tomatis and worked with his method for over a decade, the principle investigator has witnessed how children with learning challenges and developmental disorders such as Pervasive Developmental Delay (PDD), Attention Deficit Disorder (ADD), and Asperger's Syndrome have benefited from this program. However, from a scientific point of view, questions about the Tomatis Method's effects or which component influences which human functions remain unsatisfactorily answered. The more we understand how the Tomatis Method affects the brain in terms of the neural mechanisms that are being stimulated, and what cognitive and sensory-motor functions are related with this neuro-physiologic substrate, the more effective and efficient our clinical intervention will become. The most relevant questions for clinical practice are: (1) *Would this particular client benefit from work with the Tomatis Method?* and (2) *What is the most optimal training protocol for this particular client such that the least amount of treatment will yield maximum benefits?*

Understanding whether children with a specific diagnosis, such as ADD, can benefit from the Tomatis Method contributes to the first clinical question. Investigating the early effects of the Tomatis Method could be helpful to elucidate the question of the intensity and length of stimulation needed to obtain results in children with ADD.

While Tomatis (1981) provided a neurophysiologic explanatory model for his method and its effect on sensory-motor and emotional regulation, attention, memory, language, and cognition, its underlying physiological processes have not been fully understood. Vervoort, De, and Van (2007) are the only authors to report findings using neurophysiologic measures such as electroencephalograms (EEG) and event-related potentials (ERPs) while investigating effects of the Tomatis Method of sound stimulation. These authors presented single case studies in their publication of four severely delayed children treated with the Tomatis Method; the reported changes are presented in the Literature Review section of this dissertation. However, neurophysiologic measures have not yet been part of controlled research using a quasi-experimental group design that investigates the effects of the Tomatis Method. Further research is needed to explore specific effects of the Tomatis Method on the brain's physiology and how these effects relate to cognitive and other behavioral changes.

The main purpose of this exploratory study was to use a control group design while investigating the early effects of the Tomatis Method that occur in the first phase of the program. Specifically, I was interested in evaluating the impact of the first phase of the Tomatis program on certain measures of cognition, behavior, and attention, as well as on the quantitative analysis of the electrical activity of the brain. This research was conducted with 25 children ages 7-13 years old who have been diagnosed with attention deficit disorder (ADD) by physicians and psychologists. The 15 children in the experimental group were not medicated for ADD and received the first phase of the Tomatis Method treatment of sound stimulation. The first phase was comprised of 15 listening sessions of 2 hours each which were administered over a three week period. The 10 children who did not receive the Tomatis Method treatment during the study served as controls. It was challenging to find families with children diagnosed with ADD who were willing to participate when asked to serve as controls. The controls were stabilized on attention deficit medication prior to participation by their attending physicians and continued with their prescribed daily intake of medication throughout the study without alteration.

Concerta (18mg), Adderal (25 mg), Vyvanse (50mg) and Guanfacine (1.5 mg) were the various attention-regulating medications that participants in the control group were stabilized on prior to and during the study. Dosage varied from 1.5 mg for Guanfacine to 50 mg for Vyvanse depending on the medication and prescription for each child. It was a requirement that research participants in this group continue their medical treatment for attention deficit and maintain the prescribed dosage throughout the study.

It is important to address here that this study did not intend to compare two treatments such as Tomatis versus medication. Instead, this study compares the Tomatis treatment in the experimental group with the exclusion of Tomatis treatment in the control group.

Theoretical Background for the Tomatis Method

The Tomatis Effect. Alfred Tomatis received the recognition of the French Academy of Sciences in 1957 for his discovery in the field of medicine of the "Tomatis Effect." Tomatis described three principles as the core of his method of sound stimulation; these principles represent what he considered to be the neurophysiological/neuropsychological aspects of perceptual differentiation and learning:

1. The voice can only reproduce what the ear perceives. Thus, the ear has the leading role in controlling the voice.
2. When the ear is retrained to integrate frequencies it formerly did not clearly perceive, the voice automatically acquires these new frequencies.
3. If retraining of the ear occurs for a sufficient length of time, its new range of perception can become permanent.

Prior to discovering the Tomatis Effect and developing the Tomatis Listening Test (TLT) and the Electronic Ear, Tomatis accumulated professional experience working as an ENT physician while treating two distinct professional groups, both of whom seemed to present similar clinical findings (Tomatis, 1978). One group consisted of workers in an airplane factory, while the other group was comprised of opera singers. The aviation workers exhibited hearing problems as a result of continuous exposure to loud noise. The opera singers were also exposed to continuous loud sounds, mainly from their own voices when practicing or performing, and exhibited voice problems (Tomatis, 1978). These problems manifested in the form of the singers losing their ability to replicate certain frequencies with the same ease that they had been able to earlier in their singing careers. Tomatis concluded that both groups had the same presenting problem, because the issues Tomatis captured when investigating their hearing were reflected in their voice prints. As the singers' ears were not as sensitive to certain frequencies anymore (unable to perceive certain frequencies when presented at a low intensity or volume), their voice prints seemed to lack these same frequencies.

Tomatis' clinical and theoretical work resulted in his establishing the field of audio-psycho-phonology (APP). In the beginning, as an ENT doctor, Tomatis specialized in audiology. As he became exposed to opera singers, he expanded his research into the area of phonology, focusing on voice control and resonance. However, his field of interest expanded to a third dimension, psychology. As Tomatis began working with children diagnosed with autism, dyslexia, learning disabilities, and minimal cerebral dysfunction (later called ADD), he added this final aspect – psychology – to what has become the field of Audio-Psycho-Phonology (APP):

> And so, "audio-phonology" was born, spread its wings and took off…. It became obvious to me how important the involvement of psychology was in the hearing / listening progression as well as in language which began to unveil its true

> dimensions… at this point, I decided it was time to replace the hyphen separating "audio" and "phonology" to add a third dimension to the ear and the voice. And so, audio-psycho-phonology was conceived and developed. (Tomatis as quoted by Cummings, 1985)

Audio-Psycho-Phonology as Tomatis' Research Field

APP is the cross-disciplinary field that Tomatis developed in parallel with his sound stimulation technology and method. He contributed this theoretical model for a method of sound stimulation to the field of APP.

APP is based on the neuro-physiology of sensory processing and its influence on human sensory-motor and psycholinguistic abilities, as well as behavior and learning. Tomatis' APP is an interdisciplinary explanatory model that ties the role of the vestibular-cochlear system to healthy psychological functioning, and to optimal motor, language and communication development. The most recent neuroscience research on sensory-motor processing and awareness seems to support his integrative model (Patel, 2006). This author suggests that music and language rhythms both require grouping and timing in similar fashion, and both use a similar neurophysiological substrate. Moreover, humans are capable of recognizing periodicity within complex auditory stimuli and can synchronize their movements to this pattern. This indicates that recognition of and structured anticipation to temporal patterns is a basis for language, music and movement. Contrary to today's accepted theoretical models which assert that subcortical and cortical vestibular processing, visual, auditory, and other modalities are largely independent from one another, Tomatis (1981) pointed out that integrated, multi-sensory processing is involved in developing human perception, awareness and healthy psycho-emotional functioning.

Tomatis' (1981) idea that sound plays an integrative role in the central processing of other perceptual modalities is supported by recent neuroscience findings, presented below. Calvert, Spence, and Stein (2004) synthesized findings that suggest that vision alters other sensory modalities and that sound modulates visual perception in multiple ways. For instance, the authors discussed research which evidenced that brain areas involved in the early part of auditory processing project to cortical areas that involve early visual processing. These findings substantiated the occurrence of early multimodal sensory processing, which might explain, for example, mechanisms through which the auditory system announces an anticipated visual stimulus. In their publication, they also pointed out studies that explored inputs from the auditory, visual and somatosensory systems into the posterior part of the auditory cortex and the varying laminar response pattern of each sensory system. For example, the somatosensory and auditory inputs have a feed-forward pattern while the visual input has a feed-back pattern. Finally, these authors discussed studies which show multisensory integration even at the neuronal, or so called cellular level. One such study by Shams, Kamitani, Thompson, and Shimojo (2001) compared visual evoked potentials (VEP) with and without sound stimulus and concluded that sound does alter visual perception. For instance, when a single flash is presented at the same time with two auditory signals, the person perceives the single visual input as two inputs, or two flashes. These researchers suggested that sound alters temporal aspects of visual perception and that the same cortical physiological substrate is involved during the real visual event and the illusory visual perception (Shams et al., 2001). Sound also influences the perception of vision in motion. The authors also showed that a visual structure is captured in the form of auditory perception, suggesting that visual cortical processing is tightly connected to multimodal processing.

Summarizing, these findings suggest that there exist neurophysiological links between sound and vision, and that visual cortical processing does not take place independent of the processing of other sensory modalities. This theory is consistent with what Tomatis had suggested throughout many of his books, long before these findings; Tomatis (1972, 1974, 1980, 1989) described a neurophysiological dynamic and interactive model as the basis for his method. He believed that his method not only affects the processing of auditory information, but also the processing of visual, tactile, kinesthetic, and vestibular information. He pointed out that through his method of sound stimulation, auditory processing and the processing of other sensory systems are improved. Tomatis believed that, as a result of these perceptual changes, behavior, communication, and social interaction can be affected.