

Neuromusicology and Byzantine Chant. An interdisciplinary approach with multiple benefits Preliminary study, goals and prospects

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Abstract. Neuromusicology is a rapidly developing scientific branch of Musicology and Neurology. It explores, among many others, the neuropsychological impact of music, the potential treatment of human diseases through music and the perceptual brain mechanisms in auditory stimulation. In this presentation we approach the trend of Neuromusicological research at global level. We comment on the main goals, the methods (questionnaire, use of high technology fMRI [Functional Magnetic Resonance Imaging] e.t.c.) and some important findings of the current research. We emphasize the reasons why the science dealing with Byzantine Chant has a special position in this discipline and we underline the Neuromusicological approach of it since the first Christian centuries by Holy Church Fathers such as Saint Basil the Great, Saint John Chrysostom and others. Finally, we highlight the multiple benefits that can be gained through a systematic and multifaceted approach of the Chanting Science and Neuromusicology.

Περίληψη. Η Νευρομουσικολογία είναι ένας ταχέως αναπτυσσόμενος κλάδος της Μουσικολογίας και της Νευρολογίας. Διερευνά μεταξύ πολλών άλλων το νευροψυχολογικό αντίκτυπο της μουσικής, την πιθανή θεραπεία ανθρώπινων παθήσεων μέσω της μουσικής αλλά και τους αντιληπτικούς μηχανισμούς του εγκεφάλου στα ηχητικά ερεθίσματα. Σε αυτήν την παρουσίαση γίνεται αναφορά της τρέχουσας έρευνας στον τομέα της Νευρομουσικολογίας σε παγκόσμιο επίπεδο. Γίνεται σχολιασμός των στόχων που έχουν τεθεί, των μεθόδων που ακολουθούνται (π.χ. Ερωτηματολόγια, χρήση τεχνολογίας fMRI [Functional Magnetic Resonance Imaging] κ.ά.) και ορισμένων σημαντικών ευρημάτων. Αναδεικνύονται επίσης οι λόγοι για τους οποίους η Ψαλτική έχει μία πολύ ιδιαίτερη θέση σε αυτόν τον επιστημονικό κλάδο και επισημαίνεται η Νευροψυχολογική προσέγγισή της ήδη από τους πρώτους χριστιανικούς αιώνες από Μεγάλους Πατέρες της Εκκλησίας όπως ο Μέγας Βασίλειος, ο Άγιος Ιωάννης Χρυσόστομος κ.ά. Τέλος, επισημαίνονται τα πολλαπλά οφέλη που μπορούμε να αποκομίσουμε μέσα από την συστηματική και πολύπλευρη προσέγγιση της Ψαλτικής Επιστήμης και της Νευρομουσικολογίας.

*Αθηναίος: μῶν οὖν τι βλάβην ἔσθ' ἦντινα φέρει τῷ
χαίροντι πονηρίας ἢ σχήμασιν ἢ μέλεσιν, ἢ τιν'
ὠφελίαν αὐ τοῖς πρὸς τὰναντία τὰς ἡδονὰς
ἀποδεχομένοις;*

Κλεινίας: εἰκὸς γε

*Αθηναίος: πότερον εἰκὸς ἢ καὶ ἀναγκαῖον ταῦτόν
εἶναι ὅπερ ὅταν τις πονηροῖς ἤθεσιν συνῶν κακῶν
ἀνθρώπων μὴ μισῇ, χαίρει δὲ ἀποδεχόμενος...*

Plato[1]

*μὴ διὰ τῶν ὧτων διεφθαρμένην μελωδίαν τῶν ψυχῶν
καταχεῖν. Ἀνελευθερίας γὰρ δὴ καὶ ταπεινότητος ἔκγονα
πάθη ἐκ τοῦ τοιοῦδε τῆς μουσικῆς εἵδους ἐγγίνεσθαι
πέφυκεν. Ἀλλὰ τὴν ἑτέραν μεταδιωκτέον ἡμῖν, τὴν
ἀμείνω τε καὶ εἰς ἄμεινον φέρουσαν, ἢ καὶ Δαβὶδ
χρῶμενος, ὁ ποιητὴς τῶν ἱερῶν ᾠσμάτων ἐκ τῆς μανίας,
ὥς φασί, τὸν βασιλέα καθίστη. (...) Τοσοῦτόν ἐστι τὸ
διάφορον ὑγιὺς ἢ μοχθηρᾶς μελωδίας ἀναπλησθῆναι.*

Saint Basil the Great[2]

1. INTRODUCTION

Even since the 6th cent. B.C., in ancient Greece, psychophysical beneficial effects were attributed to music [3]. During the Byzantine era the Holy Fathers approached the music phenomenon based on the ancient Greek philosophers [4] and focused especially on the value of the right use of music. Music was embodied in the function of many hospitals in Constantinople as a useful tool against neurological diseases and other cases [5]. During the last decades, various scientific research centers all over the world, examine the impact of all the aspects of musical creativity in human being. These studies,

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which belong, among others, to the field of Neuromusicology, have already verified the utility of music on human being in a psychophysical level. They have also proved the central place music takes in human life and especially in relation to the human brain.

In this study we will make a first attempt to highlight the multiple benefits of the interdisciplinary approach between the science of Byzantine chant [6] and Neuromusicology. In the next section entitled "The beneficial value of music in the past", we will mention the positive effect of music on human being as it has been considered from the ancient Greeks and the Holy Fathers of the Byzantine era. In part 3. "Neuromusicology. The beneficial value of music in the present", we approach, on an introductory level, the science of Neuromusicology which studies the impact of music on human being and the brain is at the epicenter. Through a detailed study of the wide related international bibliography, we mention some characteristic neuromusicological studies which prove the usefulness of music against neurological and neuropsychological diseases [7]. In part 4. "Neuromusicology and Byzantine chant", we investigate the initial goals and prospects of the possible future approach between the science of Byzantine chant and Neuromusicology. Through such an approach it could be possible to crystallize, systematize, emerge and scientifically prove, with contemporary researches, the beliefs of the ancient Greeks and the Holy Fathers for the beneficial effect of Byzantine chant on human being.

2. THE BENEFICIAL VALUE OF MUSIC IN THE PAST

2.1. Ancient Greeks [8]

Pythagoras [9], according to Iamvlichos [10], believed in *Musical Cure (Mousiki Iatreia)*. He claimed that, through music, anyone could either be healed from different diseases or maintain his good health [11]. He distinguished and invented some melodies that were "very helpful against the spiritual passions, the despair and the acute pain, yet others (melodies) as soothing against the wrath, the anger and any deviation of the (diseased) soul" [12]. According to Iamvlichos and Porfyrios [13], Pythagoras, "with the appropriate melodies and the right use of music could convert the sorrows, the envies and strong passions, the self-indulgence and sloth into virtues" [14].

Aristotle and Plato assert that the power of music affects the human on psychophysical level [15]. Damonas [16] states that the power of music stems from the fact that music "represents movements of the soul" [17]. Thus, music both has great educational value by acting on the ethos of a person and the people in general [18], and also has therapeutic value in the soul when it is disturbed [19].

According to Plato, music submerges into soul and influences it deeply. Music affects the senses, transmits and produces feelings and meanings [20], and bears ethos [21]. Music is art and leads into the depth of feelings [22]. There is a need to be absolutely free from everything which has no religious or moral value [23]. Finally, good music coincides with the virtue of the good man, and whoever listens immoral music will be damaged by it if he likes it. On the other hand whoever listens moral music has benefits [24].

As it is mentioned above, Plato clarifies, that whoever listens and likes immoral music, will be inevitably harmed. This is a neuromusicological and neuropsychological approach to music. Neurologically, listening to music is a process which is also related with the temporal lobe. The temporal lobe is the part of the Brain which is related to the auditory perception [25] and includes heteromodal association areas. These areas in collaboration with other respective in the frontal and parietal lobe "integrate sensory data, motor feedback, and other information with instinctual and acquired memories. This integration facilitates learning and creates thought, expression, and behavior" [26]. When someone likes a melody, then he accepts it and inscribes it deeply into his memory and thereby into his inner world. Thus, the quality of the acoustic stimuli and the degree of acceptance have an impact on the way he thinks, he expresses, and behaves.

2.2. Holy Fathers

The Holy Fathers of the Church agree on several points with the ancient Greeks concerning the beneficial effects of music. They endorse basic opinions of the Greek philosophers, "they adopt, form

and embody in the Christian spirit some aesthetical and technical values of the Music of Hellenism" [27]. As it has been mentioned, they focus more on the psychophysical and neuropsychological impact of music on human being. Clement of Alexandria [28] adopts the pythagorean concept – principle of the harmony of the universe and he extends it on individual level. Thus, the universe (*macrocosmos*), but also human being (*microcosmos*) is made by God with the principle of harmony [29]. Similar and complementary opinions are expressed by Saint Athanasius [30] the Great and Saint Basil the Great [31]. These positions of the Holy Fathers show their belief that music is a beneficial tool for humanity. Saint John Chrysostom [32] notices that music also mitigates the toil and rests the soul [33] and thereby he highlights the helping role of music against psychophysiological diseases.

Holy Fathers agree to each other as far as the kind of music is concerned. They urge to, if possible, exclusive hearing of spiritual chants [34]. Church music, as a gift of the Holy Spirit [35], as a spiritual endeavour and an uninterrupted prayer can form unmistakably the human and infuse the soul with divine meanings, which remain permanently in the minds of people and can be a guide to the various circumstances of life [36]. During Byzantine era these beliefs were applied on the Hospital of Pantokrator [37] of Constantinople, where music was embodied in the medical treatments [38].

3. NEUROMUSICOLOGY. THE BENEFICIAL VALUE OF MUSIC IN THE PRESENT

3.1. The scientific field of Neuromusicology (NM)

Neuromusicology (NM) "addresses the area of brain activation" during music processes [39]. NM also "deals with the nature and evolution of the neural and cognitive mechanisms involved in musical production and perception, as well as with ontogenetic development of musical capacity and musical behavior from the fetal stage through to old age" [40].

Neuromusicology appears from the 1980s [41] as a new scientific field. Since then it has a rapid development. Its findings are of great importance [42] and they are related to the intense scientific interest of many sciences, for instance Medicine, Biology, Anthropology, Musicology e.t.c. Moreover, NM is "an integral part of Clinical Neuropsychology" [43] and a "key science in our understanding of music creativity" [44] in all its aspects.

In this introductory study we will mention some basic elements about the research methods and some interesting findings of NM.

3.2. Methods [45]

In this section we will mention briefly and with auxiliary bibliography, the methods which are used in researches related to the NM. It is very interesting to see the ways in which technological advances can provide us the ability to export useful conclusions for understanding the music creativity but a detailed investigation of these methods would extend far beyond this paper's goals.

A key tool in the development of NM are the modern neuroimaging techniques [46]. More specifically:

- Structural Magnetic Resonance Imaging (sMRI): shows the structure or anatomy of the brain.

- Functional Magnetic Resonance Imaging (fMRI): shows the areas which are active while performing a specific task and the differentiations caused by a brain disorder.

- DT-MRI: Diffusion Tensor Imaging. This method detects the structural integrity of white matter and changes in histological properties, which the previous two methods can not reveal.

It has to be mentioned that the results of the neuroimaging techniques - methods have to be combined with the results of the clinical supervision and have to be individually approached.

Additionally can be also used:

- Positron Emission Topography (PET),

- MagnetoEncephaloGraphy (MEG),

- Arterial Spin Labelling (ASL),

- ElectroEncephaloGraphy (EEG),

- Transcranial Magnetic Stimulation (TMS),
- Magnetic resonance spectroscopy (MRS),
- Event-Related Potentials (ERP) [47].

With the aforementioned methods [48] it is possible to detect more well-coordinated and highly correlated activating areas of the brain, when dealing with one or more aspects of musical creativity. The neural substrates of music are partly identified with such methods and will be identified even more minutely in the future [49]. Finally, through appropriate questionnaires we can explore the neuropsychological impact of musical activities and the perceptual background of the people as far as specific musicological characteristics are concerned, such as the rhythm, the musical mode, the embellishments, the musical texture (for instance syllabic *versus* melismatic melodies) and others [50].

3.3. Findings of Neuromusicological researches [51]

Many scientific researches of the last decades, already proved the beneficial effect of music on humans in psychophysiological level and verified, many centuries later, the beliefs of the Holy Fathers and ancient Greeks. Thus, the *Mousiki Iatreia* (Musical Cure) on which Pythagoras strongly believed [52] on the 6th cent. B.C., could be described nowadays in a few words like, "Music is an integral part of Psychiatry" [53] and "Music plays an important part in psychotherapy, therapeutic pedagogy and medical care" [54] and "Music exist in order to spread happiness and hope in human being" [55]. The exhortations of Saint John Chrysostom and Saint Basil the Great to the people to listen the right music in order to form properly the personality with divine meanings [56], are now based on the scientifically proved relation between music and temporal lobe, a part of the brain which is associated with the formation of emotion and behavior [57].

Many studies worldwide increasingly highlight the therapeutic role of music against many of diseases and disorders from the fetal stage to the old age. Indicatively, we will mention some conclusions of a number of interesting studies.

Music "can enhance quiet alert and sleep states, suck response, and oxygen saturation in premature infants and significantly reduce fear and anxiety perception in parents" [58]. Music has a positive impact on vital signs of infants while "music interventions have been shown to reduce number of days to discharge, have lessened pain response behaviours, increased weight gain, improved Brazelton scores, increased parent/infant intimacy, recovered oxygen saturation, increased formula intake, stabilized vital signs and increased parental reports of calmed infants" [59] and significant reduce of mothers' anxiety during neonatal care [60]. The combination of music making and listening can facilitate therapy and rehabilitation of neurological disorders [61]. Music training can induce and facilitate neuroplasticity to children with developmental disorders [62], while music making and training can also enhance neuroplasticity in lifetime and slow the cognitive decline in the Elderly [63].

Music stimuli "activate specific pathways in several brain areas which are related to the emotional behaviours" (hypothalamus, hippocampus, amygdala etc) and neurochemical studies have suggested that several biochemical mediators [64], such as "endorphins, endocannabinoids, dopamine and nitric oxide, may play a role in the musical experience" [65]. Many different studies have revealed the therapeutic effects of music against many neurological and psychological disorders like Alzheimer's disease [66], dementia [67], Parkinson's disease [68], multiple sclerosis [69], schizophrenia [70], depression [71] and Autistic Spectrum Disorders [72]. Music experience in such cases could improve behavioral symptoms of the patients, reduce the medication cost and improve stuff utilization [73]. It is also helpful against serious mental disorders "as a motivating factor, as a medium for emotional, expression, and as a social endeavor" [74]. Moreover, music could be used in order to partially replace the use of anxiolytic - sedative drugs during the preoperational preparation of the patients [75]. This has clearly positive results to the medication cost and the side effects of the drugs on patients. Music also has an important role in the rehabilitation of patients with Traumatic Brain Injury [76] or Acute Traumatic Brain Injury and Stroke [77].

There are indications that music has a positive effect in blood pressure, heart rate, respiratory rate, pain and anxiety in patients with coronary heart disease and myocardial infarction, reducing the risk of additional complications such as sudden death [78]. According to S. Siedliecki's study, music can

increase the impact of analgesics, reduce pain and disability and promote positive feelings to the sufferers [79].

4. NEUROMUSICOLOGY AND BYZANTINE MUSICOLOGY

The studies mentioned above (subsection 3.3.) embodied different kind of music such as music preferred by the participants, classical music (playback or live), lullabies sung by mothers, or remo ocean disc (simulate fluid sound in the womb) [80], or gato box (simulate heartbeat as it would have been heard by the neonate in the womb) [81], or white noise for infants.

This study aims to suggest the usefulness of Byzantine chant in future researches about the therapeutic role of music in psychophysiological diseases and not only. Byzantine Music has been shaped through the centuries with the goal to elevate the human spirit and tenderly balance the mental world of the listeners [82]. Thus, an interdisciplinary approach between Byzantine chant and NM could lead us to very interesting findings and multiple benefits.

4.1. Understanding the brain activity during chanting or listening to the Byzantine chant

4.1.1. Chanter [83]

Neuromusicological studies could help us to understand the brain functions which occur while singing or/and listening a Byzantine chant. A study about the brain activation for piano performing has been already presented by Edward D. Richard in his very interesting Dissertation [84]. According to this study the temporal lobe is related with the perception of pitch, the frontal lobe with the executive decisions, the parietal lobe with the motor skills and the occipital lobe with the note reading. To describe in full detail what exactly occurs in the active areas is not something simple either for a piano performer or a Byzantine chanter. However such researches promised to be very interesting.

The brain activation while singing a Byzantine chant is a very complicated process because the one who chants:

- Reads the hymnographic and the musical text or reads the hymnographic text and renders the melody according to the known Byzantine musical formulas the so called *theseis* [85].
- Recalls from his memory the hymnographic text and the melody which is already known or recalls from his memory the text and renders the melody according to the known Byzantine musical phrases the so called *theseis*.
- Performs bodily movements with his mouth and the whole voice system which extends on almost the whole body.
- Manages the volume, the pitch, the rhythm and all the hermeneutical elements of the singing.
- Perceives and organizes the hymnographic text and the musical phrases.
- Listens the choir in which he may sing.
- Receives the feedback, from all the aforementioned processes.
- Controls and differentiates everything which has to change according to the feedback.
- Prays [86].
- Takes part in a Service according to the *Typiki diataksi* (Typical order - Typikon) [87] of the Service.

4.1.2. Listener

The listener has an energetic role while listening a Byzantine chant because he might be in the state of prayer. Furthermore, he/she perceives the melody according to all the elements which describe his/her personality. More specifically, a listener:

- Listens the hymnographic text combined with the melody.
- Understands and analyzes the text and the melody according to his personality
- Maybe pray

Although the processes mentioned above show similar features for all people, they might be importantly differentiated for each person, as they are expressed in each brain individually. That happens because the activation of the brain is a result related to multiple factors. Such factors are the

age of the person, the possible musical education, the musical preferences, maybe the genre, the structure and anatomy of the brain, the mood and generally all the factors which constitute the whole personality. Thus, the very same tune can have a different impact either on different persons or on the very same person but in a different moment.

5. Epilogue and Prospects

Neuromusicology, as a rapidly developing scientific field, needs useful tools for further research. Byzantine music aims to the human benefit and can be one of these tools. Possibly it could be very helpful against human diseases but also it can be useful for enhancing the mental balance even of the healthy people. Finally, such future investigations on the neuropsychological impact of some specific musicological characteristic of the Byzantine chant could be very useful. These could be the: music mode, the musical texture, the hymnographic text and elements of performance such as: pitch, volume, choral or solo rendition. A systematization of our knowledge for these parameters could upgrade the results of the Neuromusicological researches.

References

- [1] Plato, Republic, Book II, Laws 656a-b and 656d. See: Immanuel Bekker, *Platonis et quae vel Platonis esse feruntur vel Platonica solent comitari scripta Graece omnia ad codices manuscriptos*, vol. 7, London: Priestley, 1826, pp. 513-514.
English translation:
"Athenian: Now, does a man's enjoyment of bad bodily movements or bad tunes do him any harm? And does it do him any good to take pleasure in the opposite kind?
Clinias: Probably.
Athenian: 'Probably'? Is that all? Surely there *must* be a precise analogy here with the man who comes into contact with depraved characters and wicked people, and who does not react with disgust, but welcomes them with pleasure..."
See: J. M. Cooper, *Plato Complete works*, Edited, with Introduction and Notes, assist. ed.: D. S. Hutchinson, Indianapolis: Hackett Publishing Company, 1997. For the moral and spiritual *versus* the vicious melodies in the past see also: Im. Bekker, *Platonis*, vol. 7, 656a-b, 656d and 657a-b, pp. 513-517.
- [2] Basil the Great, Speech "Προς τους νέους, όπως αν εξ Ελληνικών ωφελοίντο λόγων," *Patrologiae cursus completus, Series graeca*, J. P. Migne, Michigan: University of Michigan, vol. 31, 1897, pp. 581-584 [563-590]. Published in: <http://books.google.gr/books?id=ZhZAAAAMAAJ>, 30/01/2014.
See: a) Study Group of Palaeography of Byzantine Music (Study Group P.B.M.) from the Aristotle University of Thessaloniki, "Sf. Ierarh Vasile cel Mare și muzica bizantină," Workshop in Masterclass de cânt bizantin, ediția a VI-a. Iasi: University of Arts, 8/07/2013. Collaboration with "Floralia" from the Department of Musical Synthesis, Musicology, Music Education and Theatre of the aforementioned University. b) Study Group P.B.M., "Basil the Great and the Music," Music-educational presentation in collaboration with the Byzantine Choir of the Musical Department of A.U.Th. (M. Alexandru) and the Musical school of the Holy Metropolis of Neapolis and Stavroupolis "Josef the Hymnographer - Ιωσήφ ο Υμνογράφος" (D. Papatzalakis), in the event «Basil the Great: Music, Culture, History». Organization: Department of Music of A.U.Th in collaboration with Holy Metropolis of Neapolis and Stavroupolis. Theatre of Sykies, 25/01/2014.
English translation:
...to close one's ears to songs which corrupt the mind. For passions which are the offspring of servility and baseness are produced by this kind of music. On the other hand, we must employ that class of music which is better in itself and which leads to better things, which David, the sacred psalmist, is said to have used to assuage the madness of the king. (...) Even so great a difference does it make whether one lends his ear to healthy or to vicious music. http://www.tertullian.org/fathers/basil_litterature01.htm [20.03.2014].
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- [5] St. J. Baloyannis, "Αι Νευροεπιστήμαι εις το Βυζάντιον", *Encephalos*, vol. 49, 2012, pp. 38 and 40 (34-46).

- [6] Byzantine music is the music of the Byzantine Empire. Its continued to the Orthodox churches keeping, among others, the same modal system and the same notation with some evolutionary changes during the centuries. It flourished during the Byzantine era and its alive until to nowadays. For further introductory information see the term *Byzantine Music* on Grove Dictionary online, http://www.oxfordmusiconline.com/public/book/omo_gmo, 17/03/2014.
- [7] "Neuropsychology and Neurology of the cortical areas of the brain is the study of the brain's structures and functions in association to human thinking and behavior". This is a condensed approach of the term from Professor Stavros J. Baloyannis during a Seminar in Neurosciences at the Institute for Research on Alzheimer's disease (8th of May 2014).
- [8] One of the oldest references to the beneficial effect of music is related with the King David who played music in order to sedate the psychological confusion of King Saul. ...καὶ ἐγενήθη ἐν τῷ εἶναι πνεῦμα πονηρὸν ἐπὶ Σαούλ καὶ ἐλάμβανε Δαυὶδ τὴν κινύραν καὶ ἔψαλλεν ἐν χειρὶ αὐτοῦ. καὶ ἀνέψυχε Σαούλ, καὶ ἀγαθὸν αὐτῷ. καὶ ἀρίστατο ἀπ' αὐτοῦ τὸ πνεῦμα τὸ πονηρὸν. [English translation: ...And whenever the tormenting spirit from God troubled Saul, David would play the harp. Then Saul would feel better, and the tormenting spirit would go away. <http://www.biblestudytools.com/nlt/1-samuel/passage/?q=1-samuel+16:16-23> (21.03.2014)]. Old Testament, Samuel A, 16:16-23. See: Ath. Vourlis, *Η ἱερά Ψαλμωδία ως μέσον αγωγῆς. Ηθικομουσικολογική μελέτη*. Athens: Το Περιβόλι της Παναγίας, 1995, p. 21. See also: a) K. von Wild, "Music and Mind. The Significance of Music for Human Health, Skills, and Social Competence," in Proc: 3rd International Congress Clinical Neuromusicology, Brescia, Italy, 2012. To be published. b) Archim. N. Paris, *Εκκλησιαστικό άσμα*, p. 20. c) Basil the Great, Speech "Προς τους νέους," *Patrologiae cursus completus*, p. 584. d) Study Group P.B.M., "Sf. Ierarh Vasile cel Mare și muzica bizantină". e) Study Group P.B.M., "Basil the Great and the Music". f) *Patrologiae cursus completus, Series graeca*, J. P. Migne, Michigan: University of Michigan, vol. 31, 1897, p. 581.
- [9] Great ancient Greek mathematician and philosopher. Leader of a large religious – political movement. He was born in the middle of the 6th century B.C. in Samos and died in 490 B.C. in Metapontio of South Italy. See: P. Kaimakis, "Φιλοσοφία και Μουσική. Η Μουσική στους Πυθαγορείους, τον Πλάτωνα, τον Αριστοτέλη και τον Πλωτίνο," *Μεταίχμιο*, 2005, pp. 22-23. See also: *Νεότερον Εγκυκλοπαιδικόν Λεξικόν*, Β. Δ. Θεοφανείδης, vol. 13, ed. ΗΛΙΟΣ: Athens, p. 495.
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Iamvlichos was a neoplatonic philosopher, student of Porphyrios and teacher, among others, of Sopatros. He was born in around 270 and died possibly before 320 A.D. Apart of philosophy he also treated mathematics and he inspired philosophical and religious systems. "Pythagora's life" belongs to his work. See: *Νεότερον Εγκυκλοπαιδικόν Λεξικόν*, Κ. Δ. Γεωργούλης, vol. 9, εκδ. ΗΛΙΟΣ: Athens, pp. 753-754.
- [11] G. Ntziouni, Ch. Spyridis, "Μουσική Ιατρεία", pp. 3-6.
- [12] Greek prototype text: *ως εξαιρετικά βοηθητικές, για να αποκαθίστανται τα ψυχικά πάθη, η απελπισία και οι οξείς πόνοι και άλλες πάλι (μελωδίες τις επινόησε) για (να καταπραΰνει) την οργή, τον θυμό και σε κάθε παρέκκλιση της ψυχής (που νοσεί) ibid*, pp. 7-9.
- [13] Porphyrios was a neoplatonic philosopher and student of Logginos and Plotinos. He was the teacher, among others, of Iamvlichos. He was born in 232 A.D. and died in 304. He wrote about the life of Pythagoras. See: *Νεότερον Εγκυκλοπαιδικόν Λεξικόν*, Σ. Ε. Λυκούδης, vol. 16, ed. ΗΛΙΟΣ: Athens, p. 313.
- [14] Greek prototype text: *με τις αρμόζουσες μελωδίες και την ορθή χρήση της Μουσικής μετέστρεφε τις λύπες, τους φθόνους και τα δυνατά πάθη, τη μαλθακότητα και την κωθρότητα σε αρετές*. G. Ntziouni, Ch. Spyridis, "Μουσική Ιατρεία", pp. 2, 3 and 7.
- [15] Z. Papadopoulou, "Μουσική και ψυχοσωματική αγωγή στην Αρχαία Ελλάδα," *musical-kinetic events as a treatment mean*, 2003, p. 76 (75-87).
- [16] Damonas was an Athenian musician of great education and lived around the middle of the 5th century A.D. He was student of Agathoklis and Lamproklis (in Music) and of Prodikos (in Philosophy). He was a teacher, among others, of Perilkis, Sokratis, and the musician Dracon. See: *Νεότερον Εγκυκλοπαιδικόν Λεξικόν*, Σ. Ε. Λυκούδης, vol. 5, ed. ΗΛΙΟΣ: Athens, p. 771.
- [17] Z. Papadopoulou, "Μουσική και ψυχοσωματική αγωγή," p. 76.
- [18] Damonas claimed that the development of music as a perfect mean of education for the people, presupposes the existence of highly developed culture on each level. He mentoned: *Ούδαμοῦ κινδύναι μουσικῆς τρόποι, ἄνευ νόμων πολιτικῶν τῶν μεγίστων*. See: *Νεότερον Εγκυκλοπαιδικόν Λεξικόν*, Σ. Ε. Λυκούδης, vol. 5, ed. ΗΛΙΟΣ: Athens, p. 771.
- [19] Z. Papadopoulou, "Μουσική και ψυχοσωματική αγωγή," p. 76.

- [20] Archim. N. Paris, *Εκκλησιαστικό άσμα*, p. 20. Cf.: D. Themelis, "Μουσικοποιητική δομή στο ελληνικό τραγούδι," *Laographia* vol. 28, 1972, p. 68. Original text: Plato, *Public III*, LCL, 401d. See: Immanuel Bekker, *Platonis et quae vel Platonis esse feruntur vel Platonica solent comitari scripta Graece omnia ad codices manuscriptos*, vol. 6, London: Priestley, 1826, pp. 421-422.
- [21] E. Chatzinikolaki, "Μουσική Παιδεία," Master thesis, Department of Philosophy and Pedagogy, Faculty of Philosophy, Aristotle University of Thessaloniki, Thessaloniki, 2007, p. 17. Digital Archive of A.U.Th: <http://invenio.lib.auth.gr/record/107721>, [05.02.2014]. Cf.: Jaeger Warner, *Παιδεία*, vol. 2, transl. Γεωργίου Βερροίου, Paideia: Athens, 1971.
- [22] Edward A. Lippman, "Musical Thought in Ancient Greece," p. 73. Πηγή: Internet archive – American Libraries. Published: <https://archive.org/details/musicalthoughtin00lipp>, [02.02.2014]. Cf. C. J. Despotopoulos, "Η κριτική του Πλάτωνος για την ποίηση," *Χρονικά Αισθητικής*, 1966, pp. 107-136. See also: E. Chatzinikolaki, "Μουσική Παιδεία," p. 16.
- [23] E. Chatzinikolaki, "Μουσική Παιδεία," p. 17.
- [24] *Ibid.*, "Μουσική Παιδεία," p. 17.
Plato Laws 656a, 656b και 656d. see: Im. Bekker, *Platonis*, vol. 7, pp. 513-514.
I would like to thank Mrs Maria Salonikiou, teacher of Philology for her contribution to the translation of the original text of the Plato's Laws from the ancient Greeks to new Greeks.
Julia Annas also notices the Platonic beliefs for the impact of music on humans:
Julia Annas, "Plato's Laws and Cicero's de Legibus," in: Aristotle, Plato and Pythagoreanism in the first century BC: New Directions for Philosophy, Malcolm Schofield (ed.), Cambridge: Cambridge University Press, 2013, p. 208. See also: Ingo Gildenhard, "Of Cicero's Plato: fictions, Forms, foundations," in: Aristotle, Plato and Pythagoreanism in the first century BC: New Directions for Philosophy, Malcolm Schofield (ed.), Cambridge: Cambridge University Press, 2013, p. 246.
- [25] St. J. Baloyannis, *Νευρολογία*, vol. 2, Thessaloniki: Πουρνάρας, 2002, p. 215.
- [26] A useful Overview of Cerebral Function "www.merckmanuals.com" [22.03.2014]. Published in: http://www.merckmanuals.com/professional/neurologic_disorders/function_and_dysfunction_of_the_cerebral_lobes/overview_of_cerebral_function.html
- [27] Archim. N. Paris, *Εκκλησιαστικό άσμα*, pp. 16-17. See also: J. Plemmenos, *Συζητώντας για την Ελληνική Μουσική. Ένα διαχρονικό ταξίδι, 4^{ος} αι. π.Χ. - 19^{ος} αι. μ.Χ.*, Athens: Εν πλω, 2004, p. 130.
- [28] Klimis of Alexandria was born in around 150 A.D. possibly in Athens and died probably in 220 A.D. He embraced the teachings of Pythagoras and Plato but he also highlighted their mistaken beliefs according to the Christian religion. See: *Νεότερον Εγκυκλοπαιδικόν Λεξικόν*, Κ. Δ. Γεωργούλης, vol. 1, ed. ΗΛΙΟΣ: Αθήνα, p. 859.
- [29] Archim. N. Paris, *Εκκλησιαστικό άσμα*, pp. 17-18.
- [30] For Saint Athanasius: An. Chapsoulas, "Η κοσμική Μουσική στο Βυζάντιο του 4^{ου} αιώνα μέσα από τους Πατέρες της Εκκλησίας", *Musicologia*, vol. 19, 2007, pp. 220-224 (217-238). See also: J. Plemmenos, *Συζητώντας για την Ελληνική Μουσική*, pp. 142-143.
- [31] Study Group P.B.M., "Sf. Ierarh Vasile cel Mare și muzica bizantină". See also: a) Study Group P.B.M., "Basil the Great and the Music". b) See also: Archim. N. Paris, *Εκκλησιαστικό άσμα*, pp. 19-20. c) For Saint Basil the Great: An. Chapsoulas, "Η κοσμική Μουσική στο Βυζάντιο", pp. 227-231. d) J. Plemmenos, *Συζητώντας για την Ελληνική Μουσική*, pp. 141-142.
- [32] For Saint John Chrysostom: An. Chapsoulas, "Η κοσμική Μουσική στο Βυζάντιο", pp. 224-227. See also: J. Plemmenos, *Συζητώντας για την Ελληνική Μουσική*, pp. 143-148.
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- [34] *Ibid.*, pp. 22-26. See also: E. Wellesz, *A History of Byzantine Music and Hymnography*, edition 2nd, Oxford: Clarendon Press, 1961, pp. 94-95.
- [35] Basil the Great, *Ομιλία εις τον Α' Ψαλμόν*, 1, PG 29, 212. Cf. K. Ch. Karagounis, *Ζητήματα Θεολογίας της Ψαλτικής Τέχνης*, Volos: K. Ch. Karagounis, 2005, pp. 16-17.
- [36] Archim. N. Paris, pp. 22-26 and 33-41.
- [37] *Xenon of Pantokrator*, a teaching Hospital founded by the Emperor John B' Comnenos in 1136. See: St. Baloyannis, "Αι νευροεπιστήμαι εις το Βυζάντιον," p. 34. Cf. also: Harig Gerhard, Jutta Kollesch, "Arzt, Kranker, und Kranken pflege in der griechisch-römischen Antike und im byzantinischen Mittelalter," *Helikon*, vol. 13-14, 1973-74, pp. 256-292.
- [38] Music Therapy applied in the part of neurological diseases.: Μπαλογιάννης, "Αι νευροεπιστήμαι," pp. 38 and 40.
- [39] J. Pellitteri, "Emotional Processes in Music Therapy," Barcelona Publishers, 2009, p. 204.
The aspects of music are multiple such as: listening to music, singing, studying and playing a musical instrument, compose and thinking music and many others.

- [40] S. Brown, B. Merker, N. L. Wallin, "An introduction to evolutionary Musicology," MIT Press, Cambridge, 2000, p. 5 (3–24). See also: a) S. Brown, B. Merker, N. L. Wallin, *The Origins of Music*, ed. Nils L. Wallin, MIT Press: Massachusetts, 2001. b) J. Pellitteri, "Emotional Processes," σσ. 204-206.
- [41] In international bibliography we can find also the terms Clinical Neuromusicology and Neurological Music therapy which have to do with the Clinical application of NM.
The book "Music and Brain. Studies in the Neurology of Music" was a milestone in highlighting the importance of the interdisciplinary approach between neurology and music.
Mc. Critchley, R. A. Henson, *Music and Brain. Studies in the Neurology of Music*, Heinemann Educational Books: London, 1977.
I would like to thank Emeritus Professor Stavros J. Baloyannis for the bibliography and for his invaluable guidance and help in approaching the Neuromusicology. See also: a) S. R. Pritzker, "Encyclopedia of Creativity," Academic Press, vol. 1, 1999, p. 294. b) D. A. Hodges, *Neuromusical research: A review of the literature*, ed. D. A. Hodges – Handbook of Music Psychology, ed. 2nd, pp. 197-284, IMR Press: San Antonio, 1996.
Of special importance was the Symposium: Foundations of Neuromusicology, on 13th June 1997, Department of Music Studies, University of Ghent in Belgium.
According to the studies of Brown, B. Merker, and N. L. Wallin, Neuromusicology is one of the three branches of Biomusicology. The term Biomusicology was suggested by Niles Wallin on 1991 and consists of (except NM) Evolutionary Musicology and Comparative Musicology. See: S. Brown, B. Merker, N. L. Wallin, *The Origins of Music*, p. 5.
The term Biomusicology seems to be for a first time referred on: N. L. Wallin, Biomusicology: Neurophysiological, Neuropsychological and Evolutionary Perspectives on the Origins and Purposes of Music, Stuyvesant: New York, 1991. Cf.: R. Bret, "Using the Elements of Rhythm, Flow, and Tone to Create a More Effective and Persuasive Acoustic Experience," Journal of Legal Writing Institute, vol. 16, 2010, p. 72 (65-116). Internet source: "SSRN", <http://ssrn.com/abstract=1805723>, [01.03.2014].
It has to be clarified that this determination of Biomusicology and its branches is not compatible, if not totally opposed, with a classical determination of the main Musicological branches in: a) Systematic Musicology, b) Historical Musicology and c) Ethnomusicology. See indicatively the term *Musicology* on Grove Dictionary online, http://www.oxfordmusiconline.com/public/book/omo_gmo, 16/02/2008.
- [42] See below next section: Findings of Neuromusicological researches.
- [43] M. Botez, T. Botez, M. Aubé, "Neuromusicology, an integral part of clinical neuropsychology," L'union médicale du Canada, 112(4), , 1983, pp. 366-372.
- [44] S. R. Pritzker, "Encyclopedia of Creativity," p. 294.
- [45] The brief presentation of the methods which follows below is based on two main sources where the reader can find further information: a) R. D. Edwards, "The Neurosciences and Music Education: An Online Database of Brain Imaging Neuromusical Research," Dissertation in Faculty of The Graduate School, University of North Carolina, Greensboro, 2008, pp. 53-59. b) The methods which are used in the Neuroimaging Laboratory of Gottfried Schlaug, Professor of Neurology of the University of Harvard. These methods, except of the already published works, are shortly described also on: "www.musicianbrain.com," <http://www.musicianbrain.com/#methods>, 12/03/2014.
- [46] Indicatively, a research which embodies neuroimaging methods: G. Schlaug, A. Norton, K. Overy, E. Winner, "Effects of Music Training on the Child's Brain and Cognitive Development," Annals New York Academy of Sciences, vol. 1060, 2005, pp. 227-228 (219-230).
A voxel-based morphometric analysis (on brain) of non-musicians comparing with amateur and professional musicians: *ibid.*, p. 220. Comparison between musicians, keyboard *versus* string player, for gross-anatomical differences in the precentral gyrus: *ibid.*, p. 221. Significant group activations on brain during rhythmic and melodic discrimination tasks in five- to seven-year-old children, naive for instrumental music training: *ibid.*, p. 223. Voxel-based morphometry study comparing nine- to eleven-year-old instrumentalists with matched nonmusician controls: *ibid.*, p. 225. Statistical parametric images superimposed on surface renderings of standardized anatomical brains depict significant group activations during rhythmic and melodic discrimination tasks in nine- to eleven-year-old children with and without instrumental music training: *ibid.*, p. 227. Statistical parametric images superimposed on standardized anatomical brains show significant activations during a melodic discrimination task in a group of professional musicians and a matched group of nonmusicians: *ibid.*, p. 228.
- [47] A. B. Karapetsas, N. Ch. Zigouris, "Η χρήση των γνωστικών προκλητών δυναμικών," Encephalos, vol. 48(3), 2011, p. 118 (118-127).
- [48] There are also other methods which are mainly based to the aforementioned, such as: tDCS: Transcranial Direct Current Stimulation and others. There are also psychophysical methods.

- [49] Last years are annually published more than 500 neuroimaging brain studies in international worldwide. See: R. D. Edwards, "The Neurosciences and Music Education," p. 59.
A small percentage of them are related with music but the findings are already important and they widen the prospects for future studies.
- [50] A study with questionnaires is already in progress by the writer in the framework of his thesis. The neuropsychological impact of the musical mode and the musical texture is investigated.
- [51] These are interdisciplinary researches. They are in the scientific field of NM and Music Therapy and others.
- [52] See section 2.1.
- [53] M. S. Solanki, M. Zafar, R. Rastogi, "Music as a therapy: role in psychiatry," *Asian Journal of Psychiatry*, vol. 6(3), 2013, pp. 193-199. See also: A. De Soousa, "The role of Music Therapy in Psychiatry," *Alternative Therapies In Health And Medicine*, τ. 11(6), 2005, pp. 52-53.
- [54] E. R. Gasenzer, E. A. Neugebauer, "Die Beziehung von Musik und Medizin", pp. 2644-2651. Summary in Pubmed: <http://www.ncbi.nlm.nih.gov/pubmed/22169917#>
- [55] An opinion expressed by Stavros Baloyannis, Emeritus Professor of Neurology of the Aristotle University of Thessaloniki (A.U.Th), during his speech "Music and Brain", in the Department of Music Studies of A.U.Th on 20.05.2014.
- [56] Archim. N. Paris, *Εκκλησιαστικό άσμα*, pp. 20, 32 and 40.
- [57] See end of section 2.1.
- [58] For premature infants: a) J. Loewy, K. Stewart, A. M. Dassler, A. Telsey, P. Homel, "The effects of Music therapy on vital signs, feeding, and sleep in premature infants," *Pediatrics*, vol. 131(5), 2013, pp. 902, 905, 907-910. b) D. Discenza, "Prematures and feeding therapy: new lullaby-powered research," *Neonatal Network*, vol. 32(6), 2013, pp. 429-430. c) J. Standley, "Music therapy research in the NICU: an updated meta-analysis," *Neonatal Network*, vol. 31(5), 2012, pp. 311-316.
- [59] Ann Marie Chiasson, Ann Linda Baldwin, Carrol McLaughlin, Paula Cook, Gulshan Sethi, "The Effect of Live Spontaneous Harp Music on Patients in the Intensive Care Unit," *Hindawi Publishing Corporation*, vol. 2013, article ID: 428731, (6 pages), 2013.
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- [82] Ath. Vourlis, Η ιερά Ψαλμωδία, p. 20.
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- [86] In Christian religion the *Byzantine chant - Psalmody* and praying are directly connected. Nowadays however with the widespread use of multimedia someone can listen to or learn Byzantine Music due to ethnomusicological interest and independently of religious beliefs.
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Dimosthenis Spanoudakis was born in Thessaloniki and started his musical studies with tzoura (traditional-folk music instrument) in 1989. He graduated from the Music High School of Thessaloniki (2001) while he also studied Byzantine music (certificate 2006 & diploma 2009 with Petros Papaemmanouil) and classical harmony-counterpoint (2007 with Vasileios Kitsos). He studied Musicology in Aristotle University of Thessaloniki (2008, School of Musical Studies, Faculty of Fine Arts). He continued his post-graduate studies in "Byzantine Musicology and Chanting Art" with Prof. Fr. Spyridon Antoniou (School of Theology, Department of Pastoral Theology, A.U.Th). Now he is continuing his PhD studies in Byzantine Music with Prof. Maria Alexandru (School of Music Studies, A.U.Th.). He is a member of the Study Group for Byzantine Musical Palaeography from the School of Musical Studies of the A.U.Th (scient. supervisor Maria Alexandru) since 2006. He had presentations in International Musicological Conferences in Athens, Thessaloniki, Belgrade and Iasi. Interests: Analysis and Palaeography of Byzantine Music. Neuromusicology and Cognitive Sciences of Music, Traditional singing and Chanting Art.