

REVIEW

By Assoc. Prof. Dr. Miglena Tzenova,

Institute of Art Studies – BAS

Department of Music

on the dissertation of

Ivan Kostadinov Yanakiev

On the subject:

THE CONCERT SYSTEM $A^1 = 432$ HZ AND THE OPEN FIFTHS: AN ATTEMPT AT INTEGRAL ACOUSTIC, PSYCHOPHYSIOLOGICAL, COGNITIVE AND PRACTICAL RESEARCH

for acquiring the educational and academic degree Doctor
academic specialty 05.08.02. Musicology and Music Art,
Professional direction 8.3 Musicology and Dance Art

The dissertation *The Concert System $A^1 = 432$ Hz and the Open Fifths: An Attempt at Integral Acoustic, Psychological, Cognitive and Practical Research* is an interdisciplinary, multidimensional study.

Parallel with the work on the dissertation Ivan Yanakiev leads two research projects: "Intonation and Concert System $a^1 = 432$ Hz: Bulgarian and World Practice, Variability, Impacts and Results" (2016 - 2017) and "Systems of Temperament and Intonation in the 20th century" (2017 - 2019). Both projects were implemented with the support of the "Program for Support of Young Scientists (and Doctoral Students) at BAS". During his work on the dissertation Yanakiev also participated in the collective project "Contemporary Musical Composition, Theory and Philosophy", led by Prof. DSc Milena Bozhikova (scientific supervisor of Yanakiev); the project is supported by the NSF at the MES. The dissertation also participates in the project "Cultural Integration and Sustainability of the Balkans", developed between BAS and the Macedonian Academy of Sciences and Arts (*Македонска академија на науките и уметностите*, МАНУ).

The dissertation requires a number of competencies, including work with programming languages, computer interface, specialized software products. That is why Ivan Yanakiev completed a distance learning course in *MatLab* at *Stanford University*.

Important for the research is the personal experience of the author as a conductor of "Chamber Orchestra 432", Sofia, as well as a conductor of church choirs in Sofia churches.

The publishing activity of the author cover two (2) studies and nine (9) articles. The studies "The Relationship between Language and New Music"¹ and *Mathematical Devices in Aid of Musical Theory Composition and Performance*² have been published in editions edited/compiled by Prof. DSc Milena Bozhikova:

Contemporary musical thinking. Composition, Mediation, Directions in the 21st century (2019) and *Music between Ontology and Ideology* (2020). Six of Yanakiev's articles have been published in editions of the Institute of Art Studies, BAS: *Journal of Bulgarian Musicology* (2015, №2)³ and in collections of the annual international academic conference Art Studies Readings (2016, 2017, 2018, 2019, 2020)⁴. The remaining articles were published in the Serbian electronic edition *Accelerando* (*Accelerando: BJMD*, 2018)⁵, in the collection *Dynamics of Cultural Processes* (2019)⁶ and in *Doctoral Readings 2018. Collection of materials from a scientific meeting of doctoral students at the NMA "Prof. Pancho Vladigerov"* (2019)⁷. Yanakiev also has a publication in the electronic edition *Art Platform*⁸.

The PhD student has presented papers in English, Bulgarian and German at international and national academic and scientific-practical forums held in Skopje, Sofia, Moscow, Varna and Kazan (2014 - 2019)⁹.

Yanakiev also developed active promotion activities through public lectures and demonstrations, delivered in Bulgarian and English¹⁰.

¹ Янакиев, Иван. Връзката между езика и новата музика – опит за интердисциплинарен дискурс. – В: Божикова, Милена, съст. *Съвременна музикално мислене. Композиция, медиация, посоки в XXI век*. София: „Проф. Марин Дринов“, БАН, 2019. с. 141 – 163.

² Yanakiev, Ivan. *Mathematical devices in aid of musical theory composition and performance*. In: Bozhikova, Milena, ed. *Music between Ontology and Ideology*. [Newcastle upon Tyne]: Cambridge Scholars Publishing, 2020, pp. 36 – 60.

³ Янакиев, И. „Втори конгрес на Обществото за теория на музиката“. – В: *Българско музикознание*, 2015, №4, с. 106 – 110.

⁴ Янакиев, И. Какво чува този, който (не) чува. Компаративно осмисляне на температураите. – В: *Изкуствоведски четения 2015. Изкуствата в Новото време: смесване на езиците*. София: Институт за изследване на изкуствата (ИИИЗк) – БАН, 2016, с. 296 – 308; Янакиев, И. Въпросът за концертния строй през XX век – генезис и история на проблематиката. – В: *Изкуствоведски четения 2016. Автори, течения, взаимодействия*. София: ИИИЗк – БАН, 2017, с. 244 – 252; Yanakiev, Ivan. "Role of the Golden Ratio in Perceiving Humanness by Random Generated Tones. An Empirical Study" In: *Art Readings 2017. Crossing Borders in Arts. Beyond Modern & Postmodern*. Sofia: Institute of Art Studies (IAS), BAS, 2018, pp. 151 – 161; Yanakiev, I. "Equal Division of the Octave (EDO) with More Than Twelve Notes – Concepts, Authors, Results" In: *Art Readings 2018. Art in Europe: Models and Identities*. Sofia: IAS, BAS, 2019, pp. 565 – 574; Yanakiev, I. "Tuning to Timbre. Revisiting Consonances and Dissonances in Microtonal Context". In: *Art Readings 2019. Patterns, Models, Designs*. Sofia: IAS, BAS, 2020, pp. 95 – 103.

⁵ Yanakiev, I. „The Categorical Perception of the Music Scale: A Challenge before the Microtonal Music“. In: *Accelerando: BJMD* (Belgrade Journal of Music and Dance), 2018, <https://accelerandobjmd.weebly.com/issue3/the-categorical-perception-of-the-music-scale> [8 септември 2020].

⁶ Янакиев, И. Звукови трансфери. Песните на птиците и „There was a time“ („Едно време“) от Корийн Морсинк“. – В: *Динамика на културните процеси*. София, 2017, с. 123 – 131.

⁷ Янакиев, И. Употреба на обогатена реалност (Augmented Reality) в полза на музикалната теория – поглед върху диамантите на Хари Парч. – В: *Докторантски четения 2018. Сборник с материали от научна среща на докторанти в НМА „Проф. Панчо Владигеров“*. София: НМА, 2019, с. 119 – 129.

⁸ Янакиев, И. „Човешкият глас на виолите на Краля слънце“. – В: *Платформа за изкуства*, 2016 – 2017, № 2, с. 51 – 56, <http://artstudies.bg/platforma/%d0%b1%d1%80%d0%be%d0%b9-2-2/> [8 септември 2020].

⁹ See Ivan Yanakiev's CV, 26.06.2020, p. 2 – 3.

¹⁰ Ibid, p. 3-4

The dissertation has an Introduction (pp. 1 - 3), seven thematic sections (pp. 4 - 228), Results and Conclusions (pp. 229 - 236), Gratitude (p. 237), Appendix (pp. 238 - 308) and Bibliography (pp. 309 - 314).

The Introduction (designated as a structural unit "I.") presents the objectives, methods and structure of the study.

Section "II. The Concert A - History of Standardization and State of Modern Practice" (pp. 4 - 25) defines the term "concert pitch" as "the referenced frequency to which the tone of the first octave should be tuned" (p. 4). The "standardization" of the concert pitch is conceived as a "fruit of the New Age" (p. 7). The problems are considered in historical and geographical context. "Some contemporary practices" (p. 20) are also presented, among them the activity of the "Chamber Ensemble 432" led by the author of the dissertation (p. 20 - 22).

In the next section "III. Temperament and Intonation" (pp. 26 - 88) the dissertation focuses on the understanding that "temperaments are, generally speaking, individual solutions of theorists and composers to the question posed by Pythagoras - how to arrange twelve consecutive pure fifths in one octave, since mathematically this is not possible" (p. 32). The author underlines that this mathematical inequality is "always solved by compromise" (p. 32). In a study of various solutions to the problem thus derived, Yanakiev presents definitions, mathematical models, graphic images, classification of temperaments, etc. Two methods by Maria Reynold for uneven temperament are presented in detail: "Twelve True Quintes" (1962; pp. 41-53) and "A New Method for Adjusting the Scale of Twelve Quintes" (1985; 53 - 72). Reynold's second method is called in the text "temperament" Open fifths "(pp. 56 - 236), probably for brevity and clarity. The two methods are compared with uniform temperament in a concert system of the first octave ($A^1 = 432$ Hz). Within the same section Yanakiev also presents "Methodology for Calculating the Values of Arbitrary temperament" (pp. 72 - 74), "Methodology for Preparing Arbitrary temperament from a sampled piano Steinway" (pp. 74 - 76), "Preparation of Musical Examples" (for future experiments; p. 76) and "Experimental System for Studying the Relationship Between the Number ϕ and the Perception of Synchronization in Music" (pp. 77 - 79). The two proposed methodologies are based on *MatLab* - a programming environment that offers opportunities for sound reproduction and graphical representation of different temperaments, after the preliminary development of program codes (p. 74). For the purposes of the second methodology, sampled sounds from *Steinway B*, *PianoWave*, additional software (*Avid*, *Kontakt*, p. 74), music programming languages (*CSound*; p. 75; *Pure Data*, p. 80) were used; additional notation software was added for the preparation of the musical examples (*Sibelius*, p. 75).

Section "IV. Experiments" (pp. 89 - 177) is central to the study; describes experiments conducted by Maria Reynold on more than two thousand (2000) people

in the United States, Italy, Germany, and Switzerland (p. 92). According to the results of these experiments, a predominant percentage of participants (90%) shared an "uncomfortable, depressing", "irritating and very aggressive" sound, causing "pain in the inner ear" (p. 93); describe a sound that creates a sensation of being stabbed "like a dagger" or "with a thorn", of beating "with a whip", and of spontaneous (premeditated) reactions: "at the sound of this tone they would like to jump and start to use their fists" (p. 93). Some of the sounds used in the experiment also caused additional sensations of psychophysical discomfort: "it puts a layer on your chest that you must first pierce in order to breathe freely" (p. 93), "it created contradictory tensions", "it entered the human being and went against his/her own rhythm", "it annoyed, attacked the human being, as if the sound made you anticipate evil, as if it was buzzing behind your ear and under the top of your skull, as if it wanted to force you out of your head " (pp. 93 - 94). According to Yanakiev, "Some opinions describe quite extreme, even strange impressions. In any case, we cannot ignore these results, but it is not right to blindly trust them. These, however, are verbal descriptions of psycho-physiological cognitive processes" (p. 94).

In the same section Yanakiev presents also the experiments held by him on musicians – amateurs from the *Rodina Choir* and instrumentalists (eight students (!) from the *National Music School Liubomir Pipkov*, Sofia and 12 students and professionals; p. 115). All participants in the experiments were volunteers. The survey completes a test to determine the psychological profile on the Likert scale (pp. 115, see also pp. 134 - 136). The influence of two types of uniform temperament - $a_1 = 440$ Hz, $a_1 = 432$ Hz and the non-uniform temperament "Open fifths" ($a_1 = 432$ Hz, $c_1 = 256$ Hz, $g_{is}^1 = 362.185$ Hz) is studied. The localization of the "focal point of sound on a part of the body" is also studied (pp. 96 - 99). Yanakiev describes feelings of "tension", "sharpness", "distance", shared by musicians - amateurs and professionals, during the experiments (pp. 101 - 122). One of the professional musicians who took part in the experiments shared: "I feel tension in my body and mainly in my head to the point of pain, as well as in my ears" (p. 111); another spoke about "tension in the head" (p. 127), a third told about "soft vibrations throughout the body" (p. 127). Some of the participants in the experiment also described their sensations as moving the focal point of the sound in their bodies ("in the head", "in the abdomen", "in the chest", "in the larynx, in the throat", etc.; p. 111, 112, 114, 123 - 124, 129 - 131, etc.), as well as moving the focal point from the body of the respondent in a direction "outside the body of the respondent" (pp. 130 - 131). Yanakiev draws attention to one of the perceptions of professional musicians: "A specific statement arouses special interest: "432 - calm; mental transfer to another place; trans; sleep; concentration" (p. 122). On this occasion, the respondent commented on the shared feelings as follows: "Here we touch on the idea of dissociation in the concert system 432 Hz" (p. 123).

After the experiments with the medics, Yanakiev concluded: "It is clear that experiments with the height of the concert pitch and temperament should be

conducted with professionally educated musicians who have mastered to one or another degree their instrument (voice)" (pp. 113).

In the same part of the research Yanakiev presents an online survey, also with voluntary participants - musicians, aged between 15 (!) and 60 years (pp. 134 - 177). The survey completes a test to determine the psychological profile according to the Likert scale (pp. 134 - 136; as noted, the same psychological test was applied to NMA students and professional musicians who participated in the previous experiment; p. 115). Then the perception of musical works (by Schoenberg, Liszt, Beethoven, Debussy, Ravel, Prokofiev, W.A. Mozart, Hindemith, Schubert, Denisov, J.S. Bach), played and modeled according to the three studied in the previous two temperaments experiments (the two uniform temperaments with a concert system $a^1 = 432$ Hz and $a^1 = 440$ Hz and the non-uniform temperament "Open fifths"). According to the survey findings: "the average absolute values of the definitive final answers show that 24.03% of respondents strongly prefer the concert line $a^1 = 432$ Hz, while the concert line $a^1 = 440$ Hz is the preferred sound modality for only 15.58%" (pp. 154). It is also emphasized that "there is no correlation between the degree of extroversion, openness to new experiences or emotional stability and preferences for concert system" (p. 158). In connection with the study of the perception of the temperament "Open fifths", it is stated "the even distribution of opinion between the uniform temperament and the temperament with open fifths" (p. 176).

Section "V. Diana Deutsch's theory of the relationship between speech intonation and music" (pp. 178 - 198) focuses on "correlations between speech, music and brain activity", "important for the objective observation of the relationship between certain acoustic phenomena and the responses of brain structures" (p. 183). Continuing this idea, Yanakiev proposes the hypothesis that "the tone $a^1 = 432$ Hz is related to the speech intonation of the Bulgarian language" (p. 184). In order to examine the validity of his hypothesis, Yanakiev offers analyzes of recorded speech intonations of Bulgarian children from kindergarten (pp. 185 - 189) and school (pp. 189 - 191). According to the study of the frequency correspondences of speech intonations recorded during music lessons in five different groups at Kindergarten № 69 - "Firebird", Sofia, "the predominant intonation sound modality belongs to the frequency 432 Hz. This is taken into account in the analysis of the sound recording of the five groups. An exception to this trend is the fifth group - in it all speech intonations belong to the frequency 440 Hz" (p. 189). The recordings from the courtyard, offices and corridors of School №15 "Adam Mickiewicz", Sofia, show that the dominant sound modality for the speech intonation in the recordings (...) are tones that belong to the frequency 432 Hz. In contrast to the record in the kindergarten, chromatic tones (so-called geometric mean values) are much more common here. Also, the general contour of the intonation is much richer and more varied" (p. 191).

In the same section is analyzed the intonation of singing priests in the Orthodox churches "St. Alexander Nevsky" (pp. 193 - 196), Ancient Temple "St. Petka", Sofia

(p. 197), church “St. Trinity”, (Geo Milev quarter), Sofia (p. 198). Part of the recordings of priests in “St. Alexander Nevsky” are from the archives of the Institute of Art Studies, BAS, recorded by Corr. Member. Acad. Nikolai Kaufman and Prof. DSc Elena Toncheva (p. 192). Most of the analyzed recordings were recorded personally by the dissertation student. An important conclusion from this part of the study is the following: “from the considered recordings we can say that the frequency 432 Hz and the frequencies belonging to it through pure Pythagorean relations and average geometric values of tones are a living part of church services” (p. 198).

In the next part of the study “VI. An Attempt to Create a Hypothesis for a Neurophysiological Correlation between Concert Frequencies and Temperament and the Conditions Described in the Surveys”, pp. 199 - 211) Yanakiev considers some searches in the field of acoustics, intonation, temperament, which find expression in the works of composers such as Johnston and Stockhausen (p. 200). Stephen Van Hedger's study based on an experiment with people with absolute hearing is also considered: “part of the experiment is listening to Johannes Brahms' Symphony № 1, and in the first part (about 15 minutes) the recording is manipulated so that the concert system of the work should be reduced by 2 cents per minute;” “the aim is to find out whether, after listening to music in a different concert system for 20 minutes, the absolutists would evaluate the tones of the experiment in the first part in the same way” p. 203). According to Yanakiev, “This study practically shows that placed in the context of a concert system $a^1 = 432$ Hz for more than 40 minutes, absolutists (...) tune their entire categorical system to the new concert system” (pp. 203 - 204).

Looking for “objective” method for studying the concert system” (p. 204), the dissertation examines research on brain activity caused by auditory stimuli. In these studies, perceptions and reactions elicited by different frequencies are monitored through the use of electroencephalogram (EEG) and various equipment (*Frequency Follow Response, FFR*; pp. 204 - 211). Presented are the results of a study by Stefan Kölsch, which shows that “the first activity of auditory stimuli, which we recognize by taking an EEG, comes from very deep structures - from the brainstem and is reported below 9 ms. It is independent of endogenous factors such as will, intention or attention, because it appears very early” (p. 206). According to the author of the dissertation, such studies require “the use of functional magnetic resonance imaging or positron emission tomography” (p. 208), while some effects and reactions caused by oscillations (*FFR*) “can also be captured by distant electrodes” (with 208). At the end of this section, Yanakiev proposes a methodology for studying “correlations between the brain activity of certain subcortical areas and the type of auditory stimulus” (pp. 210 - 211; see also p. 234). The guidelines are for “seeking subjective (emotional/affective) indications in favor of a certain concert system preference” “when listening to sound stimuli” (p. 213). Yanakiev also gives specific instructions on exactly which areas of the brain should be examined in the analysis of certain auditory stimuli (pp. 208 - 210). It is stated that the methodology was developed on

the basis of the experiments conducted by the author of the dissertation with volunteers (pp. 210 - 211).

In section "VII. Composer's Decisions" (pp. 212 - 223) the application of the concert system $a^1 = 432$ Hz in the composer's practice is considered. The works "Ramifications" (for 12 soloists or string orchestra) by Ligeti and "Emanations" (for two string orchestras) by Penderecki were studied. The focus here is on the work of the composer Morsink, who requires all her works to be performed in a concert style $a^1 = 432$ Hz. Among the contributions of this section is the correspondence between the author and the composer, who contributed to the in-depth analysis achieved in the detailed examination of the work *There Was a Time* (for six flutes) by the same composer.

Section "VIII" provides "Critical analysis of theories, hypotheses, statements with false and misleading platform regarding the basic concepts of the dissertation" (pp. 224 - 228).

Among the essential conclusions given in the section "Results and Conclusions" (pp. 229 - 235) is the conclusion that "the interval of the pure fifth $3/2$ is essential for all systems for organizing the tonal space" (p. 231). Another important conclusion is that "speech intonation (...) very often resides in somewhere in the sphere between music and language" (p. 232). The conclusions already given, related to the analysis of recordings in kindergarten, school, Orthodox churches, have also been confirmed. The observations already made by the experiments are presented again – the fact that most musicians - amateurs and professionals, recognize the change of concert system, as well as the transition from uniform to uneven temperament (p. 234). It is specified that "the change of the temperament from equal to good uneven is not a determining factor for the degree of liking, but on the contrary - the temperament with open fifths is accepted by the respondents in the same way as the equal temperament" (p. 234). The proposed methodology for "studying the change in activity in some of the subcortical areas" has also been confirmed (pp. 234 - 235). The author's proposal is "that concert system $a^1 = 432$ Hz" "is to be recognized as another valid and equivalent element of musical expression" (p. 235).

The voluminous Appendix (pp. 237 - 308) contains author-generated codes (based on: *CSound*, pp. 237 - 296; *MatLab*, pp. 296 - 308).

The Bibliography (pp. 309 - 314) covers 131 sources (in Bulgarian, Russian, English and German).

In conclusion, the scientific value of the proposed dissertation is obvious, the long-term work of the author on the issues under consideration, the results achieved and reasoned conclusions in this multifaceted study. As it was noted, the work is the result of the creative work of Ivan Yanakiev as a conductor of "Chamber Ensemble 432", of choirs in Sofia's temples and others. The work is also the result of the study of programming languages, music software, computer interface, as well as research in

mathematics and acoustics. The publishing and popularizing activity of the author significantly exceeds the minimum requirements for obtaining the educational and scientific degree "Doctor". The Abstract (in a total volume of 40 pages) corresponds to the content of the study.

I have observations on part of Ivan Yanakiev's scientific work and I appreciate it, but when preparing the review for the first time I got acquainted in such detail with the nature of the experiments with people, including musicians - pupils and students. Here I would like to express my personal position and concern that minors have been subjected to such experiments (pp. 115, 136), and some of the participants have experienced psychophysical discomfort (pp. 111, 127, etc.). There is also an idea of a purely professional nature - as far as it is appropriate - to prove a thesis to bring musicians (absolutists) for a relatively long time (20 - 40 minutes) in uncharacteristic sound frequencies (see pp. 99 - 100, 117, 203 - 204), which could risk and even imbalance (albeit temporarily) professional skills and especially formed auditory attitudes and experience gained in the course of their entire professional development. Personally, I am against such experiments on people, especially on formed professional absolutist musicians, and experiments with children are unacceptable to me.

Continuing thoughts on such considerations, I would like to express my ethical and humane considerations, including as an educator, regarding the induction through auditory stimuli of involuntary processes in the brains of people - musicians, including absolutists, including children, pupils and students. pp. 115, 136), participating, albeit voluntarily, in such experiments. And in this sense, many questions arise, raised by a number of experiments described in the dissertation. In order not to burden the presentation, I will focus only on some of them. To what extent is it justified to apply dissociative auditory stimuli (even in the case of "just touching on the idea of dissociation", pp. 122 - 123) to people participating in experiments, moreover, the text does not indicate whether the phenomenon is observed in a child or adult and what would be the psychological consequences if it was a child? To what extent is it appropriate during experiments to induce involuntary changes in the brain waves of people (from beta to alpha and vice versa; p. 206, etc.) or to cause psychophysical discomfort (see pp. 101 - 122, especially – pp. 111, 127)? To what extent is it justified to change the emotional state of people through the use of auditory stimuli, for example to provoke affective states such as anger, aggression, etc. in them (see pp. 89 - 90, 93, 129, etc.), moreover, that these emotional reactions arise without the volitional control of the participants in the experiments (see p. 206)? This inevitably raises the ethical question of what effect such an impact would have in the short and long term on the professional development of adolescent musicians and already established professional musicians? It is noteworthy that nowhere in the dissertation is it mentioned that the experiments conducted by Yanakiev took place under the supervision of professionally qualified

medical personnel. That is why my recommendation to Yanakiev is to seek expert assessment from qualified physicians (neurologists and others), psychologists and other competent persons.

At the end, based on the long-term work on the dissertation THE CONCERT SYSTEM $A^1 = 432$ HZ AND THE OPEN FIFTHS: AN ATTEMPT AT INTEGRAL ACOUSTIC, PSYCHOPHYSIOLOGICAL, COGNITIVE AND PRACTICAL RESEARCH I propose to the esteemed Academic Jury to award Ivan Kostadinov Yanakiev the educational and scientific degree "doctor" in the academic specialty 05.08.02. Musicology and Music Art, professional direction 8.3. Musicology and Dance Art.

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Sofia Assoc. Prof. Dr. Miglena Tzenova