



Research Article

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On the Auditory Perception of Computer Transformations in Digital Piano Music (Illustrated by Ivan Soshinsky's *Cycle Kinder Perpetuums*)

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Abstract: The article deals with the perception of modal scales, genre and musical images as well as a performer's strategy in playing microtonic music for digital piano were analyzed on the basis of three-positional interviews: "performer — listener — composer".

Keywords: computer music, digital piano, microchromatics, genetic music, musical perception, musical temperament

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МУЗЫКАЛЬНАЯ ПСИХОЛОГИЯ

Научная статья

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О слуховом восприятии компьютерных трансформаций в музыке для цифрового фортепиано (на примере цикла Ивана Сошинского «Kinder Perpetuums»)

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Аннотация: На основе проведенных автором опросов, создающих модель трехпозиционного писания: «исполнитель — слушатель — композитор», исследуются вопросы ощущения респондентами лада, жанра, образного строя и стратегии исполнительской работы над произведением в условиях микротоновой музыки, созданной для цифрового фортепиано.

Ключевые слова: компьютерная музыка, цифровое фортепиано, микрохроматика, генетическая музыка, музыкальное восприятие, музыкальная темперация

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This article focuses on a computer modification of the microtonal music, called by the authors of this concept ‘genetic music’. Its foundations were formulated by prof. Sergey Petukhov in his publications on this topic [2; 3]. The term ‘genetic music’ suggests that the microtonal system can be combined with human perception at the level of biological informational and, according to Petukhov’s hypothesis, provides not only an aesthetic, but also a therapeutic effect. According to the composer and biophysicist Ivan Soshinsky (according to his presentation at the festival “Music and Symmetry, 2016” and its subsequent publication), the genetic scale is a scale similar to the Pythagorean one. However, instead of a fifths sequence up and down from the main tone, the intervals are based on the parameters of a DNA molecule and are associated with the golden ratio.¹

The microtonic system established by Soshinsky is a hierarchical system of genetic scales. He developed a Midi Tuner computer program, which makes it possible to produce ‘genetic music’ by playing a synthesizer or a computer provided with this software. For the notation of such music Soshinsky suggests to codify each sound on the basis of an 18-tone equally tempered scale.

The first *genetic music* concerts took place in Vienna in 2015² and 2016³ as a part of scientific congresses on the interaction between art and exact sciences. Soshinsky’s cycle *Kinder Perpetuum*⁴ drew our special attention, when it was performed there by the pianist Natalia Cherkasova⁵ in 2016, and we decided to study its multidimensional perception as a composed music piece, leaving aside the problematic of *genetic music* in general and its mathematical contexts.

The cycle includes eight small pieces (1.5–2.5 minutes each). According to Soshinsky, the titles of the pieces in this program cycle correspond to the first impressions of his one-year-old son: Motor / *bibika*, Drops / *tap-tap*, Shadows, The Train / *tuh-tuh*, Little Birds, The Moon, A Little Stream, The Clock / Mechanisms / *tick-tock*. It is a kind of a piano Children’s Album, but it would be incorrect to call it so, since the music was

¹ For more details on Soshinsky’s “genetic” scales, see: [4].

² ISIS Summit Vienna 2015 — The Information Society At The Crossroads: Response and Responsibility of the Information Sciences. Vienna University of Technology, 3-7 June 2015.

³ Symmetry Festival 2016, Vienna University of Technology, Austria, 18-22 July. See the concert program: <https://festival.symmetry.hu/videos-symmetry-festival-2016-vienna/>.

⁴ This cycle was created and dedicated to the composer’s son in 2015.

⁵ Watch video from the concert: <https://www.youtube.com/watch?v=kxxH3-793WQ>.

written for a specially prepared piano. However, it would also be inaccurate to call the instrument ‘a prepared piano’ in the classical sense of the word. The instrument itself is not subjected to preparation. Moreover, it is impossible to perform Soshinsky’s cycle on an acoustic instrument, since it has to be connected to a computer, which sets the desired type of modified pitch. Thus, *Kinder Perpetuums* can only be played on a digital piano.

Soshinsky demonstrates the correspondence between the score and its real (programmatically modified) sound on the initial page of his script (Example 1):

Example 1

Example 1 consists of four musical systems, each showing the relationship between the written notation ('написание') and the actual sound ('звучание').

- System 1:** The notation is in bass clef. The sound is in treble clef. A dashed line labeled '15^{ma}' spans the first two measures of the notation. A second dashed line labeled '8^{va}' spans the last two measures of the notation. A dashed line labeled '15^{mb}' is at the bottom of the sound staff.
- System 2:** The notation is in bass clef. The sound is in bass clef. A dashed line labeled '8^{va}' is at the bottom of the sound staff.
- System 3:** The notation is in treble clef. The sound is in treble clef. A dashed line labeled '8^{va}' spans the last two measures of the notation. A dashed line labeled '15^{ma}' spans the last two measures of the notation.
- System 4:** The notation is in treble clef. The sound is in bass clef. A dashed line labeled '15^{ma}' spans the first two measures of the notation. A dashed line labeled '15^{mb}' is at the bottom of the sound staff. A dashed line labeled '8^{va}' is at the bottom of the sound staff.

As demonstrated above, the audio-visual features that make this type of modification unusual for a musician reading the notes, lie in a potential inconsistency between the following parameters (with varying degrees of it):

- registers of the musical notation and registers of the real sound. For example, the notes transcribed in the deep contraoctave zone⁶ may sound in the third octave and higher; by contrast, the notes recorded in the high register may sound in the deep bass register;
- the graphic note pattern and its corresponding sound line, in its intervals (limping graphic patterns may turn out to be a smooth melodic line) as well as in the line direction (ascending and descending lines in music graphics and its sound form may differ).

Another audible register feature is the ability of a digital piano to produce sounds in virtual heights not represented on a physical keyboard, namely: in the ultra-low (below the subcontraoctave) and the ultra-high (above the fourth octave) zones.

The described audio-visual features make it difficult for a pianist playing from sight to implement the usual *foresight – pre-hearing* cognitive scheme. A performer of Soshinsky's cycle routinely reading half a beat ahead will not receive an anticipated auditory confirmation.

Some additional audio-visual problems include the cycle's microchromatic intervals. Soshinsky provides the score with a legend to the symbols of microtonic raising and lowering of the pitch (Figure 1):

Piano modificato

MidiTuner: 5-stages genetic nonmonotonic scale
(delta=0.38848)

повышение: (raising)	понижение: (lowering)
♯ на 3/4 тона	♭ на 3/4 тона
♯ на 2/3 тона	♭ на 2/3 тона
♯ на 1/2 тона	♭ на 1/2 тона
♯ на 1/3 тона	♭ на 1/3 тона
♯ на 1/4 тона	♭ на 1/4 тона
♯ ↑ на 1/6 тона	♭ ↓ на 1/6 тона
♯ отмена повышений/понижений (cancellation of raising / lowering)	

Figure 1

⁶ Hereinafter, we mean the preferential zone.

This article concentrates on these particular aspects of the cycle's notation and sound and will consider its multidimensional perception by the composer, a performer and their audience. We will identify the similarities and differences in their ways of hearing on the basis of a combined musicological and psychological analysis.⁷ The survey data (feedback) were obtained through oral and written interviews of the composer, pianist Natalia Cherkasova and first-year Moscow Conservatory musicology and choral conducting students.⁸

Let us consider each type of the feedback separately, starting with the performer and the audience, and only after that turn to disclosing the ideas implied by the composer.

A Performer's Perspective. Natalia Cherkasova provided her oral interview with numerous piano examples to illustrate her answers.⁹

She was asked to elaborate on following points (from general to more specific):

- her step-by-step strategy in mastering the piece;
- the ways of mastering it at home on an acoustic piano;
- specific aspects and effects of her getting the feel of the musical images; Did she have to adapt in a special way?
 - What did she find particularly unusual while working on the cycle?
 - How did she solve the problems of coordinating her auditory and visual perception in the situation of a linear mismatch mentioned above (on the 'ascending — descending' and 'leap — smooth line' scales)?
 - How did she learn the music by heart (at least, to the extent required)?
 - What would she define as the highlights of the piece's tonal and modal coloration?
 - Were there any special problems in mastering the cycle's rhythm?

The most crucial of Natalia Cherkasova's answers are listed below and provided with our comments where necessary.

Working strategy. "It was important that while I was learning something completely different, my hearing, on its own level, was working for what I will hear after the preparation."¹⁰ Let us explain this idea. The main factor influencing the performer strategy is that she was learning the piece on an acoustic (unprepared) instrument (home piano). Cherkasova got the opportunity to play a computer-prepared instrument only at several occasions shortly before the concert, as well as visiting Soshinsky at his home. The process of getting familiar with the music also started in an usual way as she began to learn it from a recording — a computer audio-version, not even seeing the score. That was the pianist's way of getting used to both the sound and the images it creates.

⁷ For more details on this type of auditory analysis, see the author's monograph [3].

⁸ The author expresses her sincere gratitude to all of them. The interviewees have authorized the usage of their answers and other information in this article.

⁹ The video and audio recording of this interview are in our possession. An example of the comparative sound of individual pieces from Soshinsky's cycle (played alternately on acoustic and electronic instruments) can be found in the video recording of M. Karaseva's conference presentation in April 2017, see: <https://www.youtube.com/watch?v=Cil9m3wSec0>.

¹⁰ Here and below, quotation marks indicate the statements of the respondents.

Thus, Cherkasova's performing strategy developed more or less as follows:

- 1) *audio imprinting*;
- 2) *mental projection of the audible sound onto the keyboard* — this process, in various degrees of correctness, almost always accompanies the work of professional pianists, though it often remains unconscious;
- 3) *visual imprinting* (at the beginning of her work with the music score);
- 4) *mental visuallising of key substitution*.

The latter process may be somewhat similar to the way of sight-reading notes in different keys, when the note printed on the staff is mentally combined with this or that key on the keyboard. The difference, however, is obvious here. Sight-reading in different keys, one can be guided by the graphic image of this or that constant interval taken up or down. In the case of *genetic music*, this orientation turns out to be a useless skill, or even a handicap. This enables us to propose that genetic music's rhythmic pattern remains the main supporting structure for a successful sound *substitution*. Let us reinforce this hypothesis by the performer's own words.

The transformation of auditory pre-hearing skills. "I can compare it to some sound improvisation, which has a great rhythmic basis. And you are beginning to enjoy it. You know that you have it in your fingers, and your ears seem to be surprised each and every time. And this is a pleasant surprise. After two or three times of rehearsing, you get used to the way it is going to sound in the end."

We should note that the factor the performer is enjoying here is an *auditory surprise*. In a sense, the described transformation process can be compared to an aleatoric performance. The latter, however, more often turns out to be primarily aimed at arousing the listener's sound interest. In the case of genetic music, the listener falls out of this familiar scheme, since he does not see the written musical text, and, accordingly, cannot hear this music as a free improvisation. The listener is puzzled by a piano, producing sounds outside its usual diapason. However, it also surprises the musical ear of the performer.

Perception of timbres. "A sound can come out as a knock. The cycle contains sounds from outside a piano keyboard (lowered and heightened by means of a computer program). In these cases the timbre doesn't resemble the piano one at all."

What was routine in your work, and was there a possibility of interpretation? "Every work begins with an image. The titles [of the parts] were a lot of help. The image is primary." Thus, it is possible that the visual *substitution* on the performer's mental screen involved not only notes or keys, but also internal pictures or, perhaps, even some particular pictures (?), as often happens to amateurs, and much less often to professionals, precisely because they know the *written language* of music.

At the same time, the basic tone and rhythm parameters used by professionals retain their significance. They are automatically identified by ear, and, quite often, they become the main focus in mastering a piece. Natalia Cherkasova's answers confirm this idea.

Feeling the tonality. "In general, the cycle seems atonal. There might be some tonal parts. The first piece is written very tonally. While restructuring, the sounds become not that instrumental, but rather *industrial*. On the whole, it was not so important to me

[to hear the tonality. — M. K.], and I think it also was not the composer's aim to bring out the tonal parts.”

Working with rhythm. Were any rubato moments allowed? “No, I use a metronome and check it out. I am very meticulous about the rhythm.”

The Listener's Perspective. The survey took place after the students had listened to a recording of Soshinsky's cycle.¹¹ Musicology students listened to it at home, in no particular order and an unlimited number of times. But to choral conducting students the recording was played only once during a class. Neither the title of the cycle and its pieces, nor the name of the composer and the technical features of the performance were revealed to them. The survey was carried out as a free conversation during a solfeggio class.

Let us briefly outline the most typical answers to the questions proposed to the listeners. They were divided into music theory ones, which were more common to the students and *exotic* ones requiring a certain amount of associative thinking. Some of the questions were deliberately provocative or asked in form of a metaphor.

The results obtained by the first group of questions are as follows.

Defining the programmatic nature of the pieces and deciphering their names. This turned out to be one of the easiest tasks. Many of the respondents guessed the names of the following movements: *Raindrops, The Train, The Clock*.

Feeling of harmony and tonality. Most of the respondents easily pointed out the pentatonic blocks in the cycle, some even named its main tonal key: “It is written in G minor” (K. D).

Compositional features. The respondents mentioned the dynamic profile of the form: “One can feel the structure getting more complicated in the second half of the cycle” (K. D).

Timbre features. On the whole, it was the unusual sound that triggered the listeners' attention. But the same component made a part of the audience disapprove of this piece. “I liked the timbre for its uniqueness. But it doesn't get the hold of you. The interest goes away” (A. N.). “It's hard to listen to the upper register (especially to the one that doesn't have a definite pitch). Not physically, but because you are trying to understand what instrument does the sound come from. It is much more comfortable to listen to in the lower register” (E. T.).

An ethnic flavour. There is usually no question of finding a national element in this kind of music. It is assumed that a listener might find associations either in his or her individual sound thesaurus, or on a map of personal aesthetic preferences, which is formed, inter alia, by the phenomena celebrated in a national culture. In Soshinsky's cycle, some listeners have heard a Japanese *sound trail*. For example, *The Stream* made the students think of geisha (E. T.) and sakura (A. G.).

It is difficult to define any specifically Japanese features in the rhythm or intonations of this cycle. These associations might be based on a rather meditative nature of some fragments or its particular fragility. Japan might have been mentioned here as a geographical reference because it is a more well-known *brand* (as compared, for

¹¹ It seems that watching a video recording could have yielded a different result: the audio recording is intriguing, the audience does not quite understand how and which music instrument is being played.

example, to South Korea, just as Japanese hokku are known all over the world, but only a narrow circle of admirers is familiar with Korean poetry of the same period). It is curious, however, that the author of this article (on her very first acquaintance with this cycle at a concert in Vienna) associated it with traditional Japanese music — not in a figurative sense, but in a purely musical aspect, primarily with the peculiar sound of a non-tempered instrument.

Let us turn to the ‘exotic’ group of questions and look at the most typical answers.

Was this piece of music composed rationally or intuitively?

“It came from the head as there are too many structural elements, like similar blocks. The composer made up a model and followed it” (D. B.). “It’s hard to model a figurative sphere. It is unclear what this is all about. It would be clearer with lyrics” (S. Ch.).

What is the ratio of human – unhuman in the figurative sphere of the cycle? “We hear the human most in the parts with syncopations and genre principles” (D. B.). The respondent, probably, means such movements as *Trains*. The register turned out to be the main musical component responsible for the unhuman. It was mentioned that the sound in the extreme registers of the instrument created the unhuman feel.

The sense of time and space. “The repetition of one and the same block slows down the sense of time” (M. N.). “In the toccata parts the space becomes narrower” (M. N.).

Entering and leaving the auditory comfort zone. What do you like or dislike in this music? The respondents liked: “abrupt changes of mood — and the fact that we stay in them for a long time afterwards” (D. B.). They disliked: “the monotony — because [the cycle] is built on a register correlation principle. We are losing interest” (K. D.). “I mean, where is your symphonic style, where is your development?” (A. N., half-jokingly).

The students described their multimodal sensory experience after listening to the cycle at home as follows:

“I liked the first and the second movements. I feel:

In the first movement: black and white stripes, dynamics, graphics, speed. A chase, tension, adrenaline. Determination, strength.

In the second movement: Glass sticks. Transparency, fragility, sharpness. Broken glass, clinking glass, glass that reflects and refracts the light. [A piece of] glass hung on a string to a high black ceiling. The glass that can cut. A cut on my finger. Something cold. Stay aside, do not come close, do not touch. The sound of a wineglass shattering. A damp smell. A salty taste on my tongue.

And then I got bored...” (V. L.).

— *Who would have liked listening to this music?* “Composers or experts. It is psychologically hard to listen: it can put too much pressure on an ordinary person” (K. D.).

It will be especially interesting to look at the cycle from **The Composer’s Perspective** after informing ourselves about the reaction of his audience:¹² Ivan Soshinsky provided us with written answers to the questions sent to him by the author of this article.

¹² The material was sent by Ivan Soshinsky in a personal message and supplied with this comment: “In answering these questions, I will mainly have in mind this particular piano cycle *Kinder Perpetuums*, since I use different composing methods, they are always individual and often specially invented in accordance with the tasks of my composition.” The composer was not informed about the answers given by the performer and the audience.

1. *Program music and imagery. What triggered the composition? How did it come about – what came first the music or the title?*

“First the title, then the music. I took some of the first sound-images or sound-words, which had impressed my son. That is, the first few words that he learned to say (by the time he was a bit older than 12 months). The very name of the cycle can be translated roughly as *Children’s infinities*. Just as *you can endlessly look at the fire*, these images can draw a child’s attention for an *infinite period of time*. He or she is immersed in them and can play with each of them endlessly. While writing, I wanted to produce some textured options in the form of miniatures that a child could improvise at the instrument. Therefore, this cycle of miniatures is an example of how a child can learn to play piano through play and improvisation in a given texture.”

2. *The composer’s son reaction to the music. How did your main listener receive the cycle?*

“At the age of two he listened to it with interest and recognized the images. He loves trains and cars – they are his favorite toys.”

3. *The role of modal thinking. Do modal inclinations (pentatonic scale) come about by chance or on purpose?* “The pentatonic scale [in this cycle] came from the structure proposed by Professor S. V. Petukhov – the so-called ‘five-degree genetic order’, a consequence of the tuning mathematics. I just used this mode throughout the cycle. This imposed on me a complicated additional condition, namely: to write a twenty minutes long composition by means of only five sounds, without being able to apply harmonic modulations and other means of contrasting harmony. On the other hand, it has become a fundamental support linking the entire cycle into an integrated composition – all miniatures use the same five sounds.”

4. *The order of the parts. Was there any special concern about the composition of the cycle?* “Of course, when composing a cycle, a composer, one way or another, is thinking about the contrasting effects and the dramaturgy of perception. However, giving the notes to the pianist, I told her that she is free to change the order of the pieces, but she didn’t.”

5. *The composition method. Does a composer hear a sound material in the form, in which it will later sound, does he write at his desk or touching the keys (kinaesthetically), or in some other ways?* “In the process of composing *Kinder Perpetuums* all the listed methods were used. That is, prehearing in my head as well as the search for a variant with my fingers while improvising. There were also mathematical calculations, without hearing the specific sound result, but imagining more or less how the result of these calculations will sound in the end. Apart from that, some parts of the composition were written at my desk, but I heard the result in advance with my inner ear.

Despite the modifying type of notation (in which the actual sound differs from the score by a certain interval as in transposition, but with a different transposition interval for each note), all other musical parameters are preserved in the score. The rhythm, the tempo, the agogics, the understanding of form, and much more – all of it, except for the pitch. Therefore, it is quite easy for the inner ear to control the result, and if you also immerse yourself in the notation system and its mathematics, the pitch becomes quite imaginable. That is, to my mind the process of composing this cycle was quite traditional.”

6. *The requirements to a performer. What special skills (besides mastering the score text, playing techniques etc.) should a performer have?* “The basic idea of the entire system we developed (meaning a modified piano used to perform music in any pitch system) is to remain as common and comfortable for a performer as possible. Therefore, the only thing that a performer is required to do — to get used to the unusual. Or is it better to say: to get used to the unusual sound of the instrument, when your long experience of pre-hearing keys is impaired? For example, it is more than unusual to hear bass sounds, when playing in the second and third octaves. As soon as a musician overcomes this *inconvenience*, he or she can fully concentrate on his task as an artist.”

7. *A performer's ergonomics. Did you show your care for the “playing person?”* “I paid much attention to the convenience of performance. For example, due to the confusing pitch system (see the first page of my score for the legend to the piano keyboard), it was possible to use chords in close positions, clusters and scale-like passages, just the white or just the black keys, etc.”

8. *What kind of reaction would the composer expect from his audience? What would he like it to feel, hear or accept in this music? What listeners (age and qualification) did the composer have in mind?* “I believe that music, if it is really good, will be of interest to any music lover, no matter in what system it is written. So, I do not put any restrictions on my audience. The composer's task is to write high-quality music, and the audience shall decide for itself, if it wants to listen to it or not.”

Let's make some analytical generalizations based on the information received from the respondents. We can start with the positions that are more traditional in the discussions concerning the understanding of music. Thus, program music, supported by rhythm and intonation image patterns has become a solid ground on which the perception of all the interviewed groups coincided and which was positively assessed by them.¹³ An important point was also the search for a modal and tonal support, which seems crucial for understanding music by a European musically educated listener, as well as finding it, to a certain extent — with a probable, although not specified, satisfaction as the result. The questions of tuning (untempered in this case), being constructively and conceptually important for the composer, did not cause any vivid (positive or negative) reaction¹⁴ either from the audience or from the performer. It seems that the modification of the tuning was simply accepted by ear as given.¹⁵ However the reliance on tempo and rhythmic patterns united the composer's perception of his music with the performer's auditory *deconstruction* during her rehearsals.

¹³ It is also necessary to highlight the important positive reaction of the main addressee: the composer's toddler-son.

¹⁴ For example, nobody mentioned a 'false' sound, which would irritate the ear and hinder the music's comfortable perception. The performer called it 'a sonorous color' in her interview.

¹⁵ Yet, for the author of this article, the lack of temperament turned out to be the most attractive in this music.



Plate 1. Gerhard Richter. *3. Jan. 1990*. Oil on black-and-white photograph. Borrowed from Gerhard Richter's Official site (<http://gerhard-richter.com>)

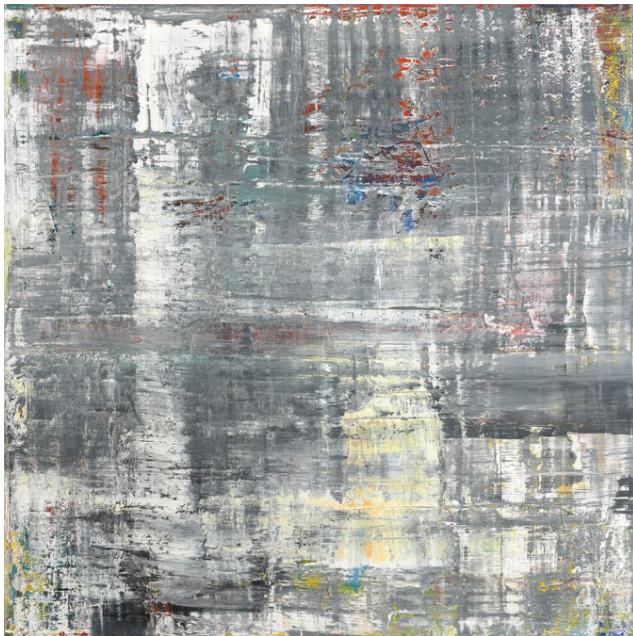


Plate 2. Gerhard Richter. *Cage 5* (2006). Oil on canvas. Borrowed from Gerhard Richter's Official site (<http://gerhard-richter.com>)



Plate 3. Gerhard Richter. *4. Jan. 1989*. Oil on color photograph. Borrowed from <https://gagosian.com/>



Plate 4. Gerhard Richter. *MV. 92* (2011). Oil on color photograph. Borrowed from <https://gagosian.com/>

The performer also adequately assessed the ergonomics of piano performance (including the composer's special concern for close arrangements in the texture).¹⁶

As we can see, the approach to this kind of 'genetic music' both by the composer and the performer turned out to be quite traditional (the program, the texture, the detailed musical text, etc.). The listeners were ready to perceive this music in the same traditional way (based on the same imagery parameter). However, this simple statement would hardly be worth a special study — it would be much more interesting to look a little deeper. If we try to touch upon the topics more complex and less familiar (for the consciousness of the respondents as well as for the musical consciousness of the audience in general), we will find that the perception of 'genetic music' raises the same range of cognitive problems as any other music, different from the standards of major-minor tonal music of the 18th–19th centuries.

One of them is the fact that each of the interviewed musicians actively uses the attitudes based on his or her individual 'sound philosophy'. In many respects such philosophy is built on some benchmark parameters being (consciously or subconsciously) applied to the peculiarities of a particular sound material. It is a kind of energy drink made of individual and / or socially widespread / socially desirable scale of values, mixed with a personal set of meta-programs¹⁷. Before we elaborate on that, let us provide an analogy from the sphere of modern painting, namely the overpainting method, used, for example, by Gerhard Richter. An artist is painting over a photographic image and as a result only some vaguely recognizable images of real objects or landscapes can be discerned (see Plates 1–3).

There are two tendencies in the perception of this painting. To a great extent, the distinction between them depends on the meta-program pair 'similarity — difference'. For a person with a marked meta-program of *similarity*¹⁸, it will be more important to identify what was originally depicted (as if cleansing the photo of incomprehensible layers, that is, recognizing what he already knows and what has been verbally labelled in his conceptual thinking). For a viewer with a meta-program of *difference*, the main attraction of Richter's paintings will lie in detecting new images in the unclear contours (from different angles of view). They (or their foretaste through mental drawing) might be incomprehensible, changing, suddenly appearing and disappearing, having no particular name to the very end. The vaguer the picture, the more interesting it may seem to the viewer with this meta-program.

Roughly the same process can take place, when a listener is perceiving unusual music. Those who have a meta-program of similarity may reject an unusual / incomprehensible

¹⁶ There were certain inconveniences, which the performer called 'incidental'. They were connected to the design of the digital instruments that the performer had to play. She notes that in the fast passages she could not always 'sound in time' (possibly due to the fact that these instruments did not have technical parameters of a 256-sound polyphony).

¹⁷ In psychology, meta-programs are the individual filters a person applies to reality, perceiving himself and the world around him.

¹⁸ I. e. with a predisposition to prefer a familiar material, and appreciate it highly for this reason. A person with a distinctive similarity meta-program would rather go to a concert of familiar music (Chopin, Rachmaninoff, etc.), than to a concert of some unfamiliar composer or music style. Accordingly, the meta-program of differences often prompts a person to make the opposite decision.

timbre / register / mode / melodic combination, etc. On the contrary, all these music elements may become a source of pleasure to a listener with a leading meta-program of difference. They might enjoy the possibility of completing the composition, guessing along its contour, for example, by means of auditory *groping* for a mode in a non-tempered tuning, or by the perception of sounds that one feels it is impossible to sing.

Keeping it in mind, let us make a generalizing assumption: listening to the musical overpainting¹⁹ in Soshinsky's cycle requires the following skills:

- in general psychological terms: to get a taste of a meditative mood;
- musically and linguistically: to induce a feeling of *auditory comfort* from being in unusual melodic and harmonic sound connections. In this case, everything that seems not entirely clear by ear inspires you to give it another try and you do it with pleasure;
- in terms of musical and aesthetic attitudes: one should be able to experience *auditory delight*, to enjoy the musical sounds themselves;

The latter means, in particular, that one does not expect the music to evoke either *romantic empathy*, or a dramatic intrigue. Nor should one look for a *hidden message* that reveals *the secret meaning* of the author's design, or anything of that kind, highly valued in the musical composition of the previous centuries. Nevertheless these parameters still constitute the musical and conceptual basis for the compilation of concert programs in most philharmonics in Russia and around the world, as well as the basis of musical literature programs on the intermediate level of musical education institutions.

In this regard, we would like to emphasize it once again: our analysis is based on the data obtained from first-year students (which, of course, does not pretend to fully cover the topic).²⁰ That is, from those, who have just graduated from the intermediate level musical schools and entered a university, equipped with the attitudes mentioned above. It would be of interest to conduct a similar survey regarding their perception of innovative music among senior conservatory students.

Another interdisciplinary analogy for 'genetic music' (which may be closer to its intended purpose) may be found in the House of Music in Vienna (*Haus der Musik*), which is a relatively new²¹ interactive sound museum. It has a dark room in which a visitor can hear the sounds that a baby in a womb can perceive. Here is a fragment from the museum's legend: "The flow of senses and meanings. The border between nonexistence, chaos and order. Fluctuating air interspersed with immobility creates a sound space. These are transformed sounds of intrauterine foetus diagnostics".

According to the organizers of this exhibition, anyone entering the zone can perceive the world from an embryo's point of hearing, owing to the body sound phenomenon. Immersed in three-dimensional sound structures from original womb sound recordings, a visitor experiences sound vibrations, perfected in the compositional aspect. In addition to body sounds, they contain sounds that affect a baby from outside. The creators of the record believe that every person experienced this feeling once, but everybody has long forgotten it.

¹⁹ As if looking at a picture.

²⁰ This survey was conducted in a solfeggio class.

²¹ The museum opened in 2000.

Perhaps something similar happens to our auditory perception when we listen to ‘genetic music’. Namely: it is possible that our subconscious is able to perceive it independently of those musical-auditory (and not just auditory) models, apart from those musical and linguistic patterns of perception that have developed over the past few centuries. However, let us leave the professional discussion of DNA-sounds to biophysicists and microbiologists. For listeners, so far, music remains music that lives according to its own rules. In this sense, a fascinating attempt at ‘children’s scenes’ by Ivan Soshinsky takes a worthy place in this musical nomination.

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