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VIRTUAL INSTRUMENTS (VSTI) IN MOVIES AS A SUBSTITUTE FOR SESSION MUSICIANS. RESULTS OF THE RESEARCH BASED ON THE SYSTEM OF ORGANIZATIONAL TERMS

Adrian ROBAK[1], Olaf FLAK[2]

Abstract

The paper aims at exploring the possibility of creating a symphonic soundtrack using electronically generated instruments (Virtual Studio Technology instrument - VSTi) that will emulate the real orchestra and will be not a recognizable by listeners. There were verified six hypothesis: H1: Music performed by acoustic instruments that are a part of the orchestra is more emotional; H2: Music performed by acoustic instruments is connected to the film more strongly (than music performed by virtual instruments that are imitating the orchestra; H3: Music performed by acoustic instruments is less distracting for the audience from the scene of the film; H4: Music performed by acoustic instruments that are a part of the orchestra is more coherent sonically; H5: Music performed by acoustic instruments that are a part of the orchestra does not change the tempo of the scene of the film; H6: Music performed by acoustic instruments that are a part of the orchestra transfer the emotions related to the scene of the film better.

The method used in this research was an non-participating observation based on reflective narrative method in which the listeners used the online research tool called NoteToday (notetoday.pl). This research tool was created on basis of the original concept of research called the system of organizational terms. The results of the research let create the knowledge of how to produce a film soundtrack using the VSTi technology and they were the foundations of an in-depth understanding of human perception when watching movies.

Keywords: Film and Music. Film. Virtual instruments. Acoustics. Music composition. Music Perception. Music and Psychology. Music synthesis and transformation. Psychoacoustics.

1. Introduction

Music is one of the most significant elements of the film. It has been understood to produce meaning only on the most abstract, spiritual or formal levels[3]. Film can be perceived as a syncretic work of art which consists of lighting, scripts, acting, a screenplay, choreography, sound effects, direction, whereas, music creates a picture

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[3] Anahid Kassabian, *Hearing Film. Tracking Identifications in Contemporary Hollywood Film Music*, Routledge, New York and London. p. 15.

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that strongly affects the audience. It is impossible to establish the number of films that would not have been considered legendary or iconic, if it had not been for music.

Nowadays, film music often tries to merge electronic music with eclectic mix of classical, rock, popular music and jazz. One could distinguish two opposite and explicit tendencies in composing film music emerging in the 1980s. First of them was writing romantic, neo-classical and neo-romantic score for large orchestras. The second one was electronic music. There was a noticeable influence of rock and pop music too. Additionally, in the late 90s composers began to use electronic instruments to imitate the orchestra. The most popular figure was Hans Zimmer who started a new approach of film scoring. In his composing process, orchestral instruments and electronic ones were equally important. He formed his characteristic musical style by applying a heavy use of synthesizers mixed with orchestra[4]. The interesting fact is that Hans Zimmer's style fluctuates through the years from using electronic instruments imitating the orchestra to imitating electronic sounds with orchestra[5].

Therefore, this paper aims at exploring the possibility of creating a symphonic soundtrack using electronically generated instruments (Virtual Studio Technology instrument - VSTi) that will emulate the real orchestra without being recognizable by listeners. There were four hypotheses established at the beginning of the research. They were as follows:

- H1: Music performed by acoustic instruments that are a part of the orchestra is more emotional.
- H2: Music performed by acoustic instruments is connected to the film more strongly (than music performed by virtual instruments that are imitating the orchestra.)
- H3: Music performed by acoustic instruments is less distracting from the scene of the film for the audience.
- H4: Music performed by acoustic instruments that are a part of the orchestra is more coherent sonically.
- H5: Music performed by acoustic instruments that are a part of the orchestra does not change the tempo of the scene of the film.
- H6: Music performed by acoustic instruments that are a part of the orchestra transfers the emotions related to the scene of the film better.

The research was carried out in January 2019 in a group of students in the University of Silesia (Krzysztof Kieslowski Faculty of Radio and Television, Katowice) who were

[4] Adrian Robak, Wojciech Wieczorek, "The use of virtual instruments in the process of creating a soundtrack with film music. Is this the twilight of film music played by man?", Proceedings of the *International Conference on New Music Concepts and Inspired Education*, Vol. 6 Accademia Musicale Studio Musica, editor: Michaele Della Ventura, Treviso 2019, p. 51-71.

[5] Elegyscores, "Hans Zimmer - Making of INCEPTION Soundtrack", Youtube, March 30th 2011, accessed January 27th, 2019, https://www.youtube.com/watch?v=W1FIv7rFbv4.

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watching and assessing a piece of a movie with the original soundtrack (played by session musicians) and the soundtrack created using virtual instruments.

The researchers wanted to compare the technique of building a soundtrack model by using VSTi in symphonic music and test differences in human perception of performances played by the musicians and VSTi. Finally, the listeners assessed the level of reality of the soundtracks' sound. They listened to a real orchestra recording and the one created with VSTi instruments. Each listener participated in the performance four times and did not know which soundtrack they would hear. The tests were conducted with an interval of several days.

The method used in this research was a non-participating observation based on reflective narrative method in which the listeners used the online research tool called NoteToday (notetoday.pl). This research tool was created on the basis of original concept of research called the system of organizational terms. The theoretical foundations for this methodological concept assume that real and mental states of the world can be recorded with online research tools or any other sensors. Mental processes can be presented by the system of organizational terms – in this case the perception of the listeners – in terms of events and things. The progress between separated mental things allows us to draw conclusions on the mental process which occurred in the listeners' minds.

The results of the research presented us with the knowledge of how to produce a film soundtrack using the VSTi technology. They were also the foundations of an in-depth understanding of human perception when watching movies. This knowledge seems to be a significant contribution to the film industry.

2. Theoretical foundations of virtual instruments performance

The use of Virtual instruments (VSTi) must have revolutionized methods of composing, scoring and soundtracks' stylistics. One person could operate virtual instruments; they are cheaper because they eliminate the need of performers, microphones and stands, space, studio, cables, acoustic instruments, hardware such as specialized pre amps and compressors. When using VSTi, it is necessary to have a keyboard and computer with Digital Audio Workstation such as Pro Tools, Logic Pro, Cubase, Reason or others which work in the MIDI domain.

In this case, several problems may occur during the music production process. First, professional musicians could recognize that the music was an artificial imitation of live instruments. Second, in order to create such music, it is necessary to know the theory of music. Third, the sequencing process is time-consuming and requires many years of a vast experience to execute this operation.

Due to a change of musical profile whereby composers used a lot of artificial sounds, virtual instruments have been applied and gained permanent place in film music industry despite the fact that live acoustic instruments will always sound more authentic and imitating their dynamic changes by virtual instruments is a nightmare for music creators. Furthermore, acoustic instruments will keep musicianship alive.

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However, it is impossible to avoid some problems when a composer tries to convert his ideas to tangible music material: film soundtrack.

First, recording sessions are expensive. Second, when inexperienced musicians record film music it requires more changes in notes or others music marks in the score to be made by a composer. Third, the human aspect during recording session requires a lot of psychological experience from recording engineers because they need perfect conditions to create an artistic interpretation.

3. Scientific gaps between artificial and live performance

For the purpose of the research process, six hypotheses were established in order to examine differences in artificial and live performance. First aspect of the research concerned the problem of emotions which are created by acoustic instruments. It is said that popular music soundtracks operate by crossing that boundary, evoking memories of emotions and subject positions, inviting perceivers to place themselves on their unconscious terrains[6]. Therefore, from the musicological point of view, a musician taking the instrument into their hand creates an inseparable duo: entity with a sound tool. As a result of interaction of this duo, not only is the sound layer performed, but also the emotional layer that has a semantic basis. The performance of the score or an individual part entails a lot of issues that affect the perception of emotionality.

For example, during a separation of first violin group consisting of fourteen players from string section, it has been noticed that all the musicians were moving the bow in the same direction (upbow or downbow), they had established dynamic level for performing every single note and during it, they had determined the level of vibrato, and other articulation elements. All these features created exceptional interpretation, which in sum created a unique emotionality. Each of the played phrases is slightly different despite repeating those phrases on the recording session.

That is why the first Hypothesis states as follows. H1: Music performed by acoustic instruments that are a part of the orchestra is more emotional.

Another aspect of film music is that it is joined with a particular scene of the film as strongly as the composer and director cooperate together firmly. This collaboration requires discussing each scene of the film, its emotionality and hidden message. Film music is often written to create an additional layer of meaning or to stand in opposition to the image. All film elements and their anastomoses create a complete production.

Driven by the statement that as a signifier of emotion, music undoubtedly makes strong suggestions of how perceivers should feel about a particular scene (…).[7] Here the second hypothesis is formed. H2: Music performed by acoustic instruments is

[6] Anahid Kassabian, *Hearing Film. Tracking Identifications in Contemporary Hollywood Film Music*, Routledge, New York and London. p. 88.

[7] Anahid Kassabian, *Hearing Film. Tracking Identifications in Contemporary Hollywood Film Music*, Routledge, New York and London. p. 41.

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connected to the film more strongly (than music performed by virtual instruments that are imitating the orchestra.)

D. Nuemeyer wrote that "music engaged an audience in the film, music adds meaning to film, and music accompanying visual images in a film forms a bond in memory".[8] It should be noted that a recording process is significantly different than creating a mock-up using virtual instruments. In the first situation, one can record the same reverb and use the same hardware to all recording tracks or clips. The final audio clip is a result of many people's work who specialize in narrow fields. In the second situation, one imitates conditions and work of that team.

It is said that "if an appropriate music soundtrack engages the interest of an audience in a film, this soundtrack should reduce detection of events extraneous to the film more than would an inappropriate music soundtrack because the latter would make the film less engaging and leave more attention to spare for extraneous material. This latter hypothesis assumes that the amount of attention of an audience member is finite and that attentive engagement to a film takes mental capacity"[9]. That is why the third hypothesis is as follows. H3: Music performed by acoustic instruments is less distracting from the scene of the film for the audience.

Another research question worth answering is which factor has a significant impact on creating perceivers' sensation that film music is more coherent sonically. Paradoxically, these are the elements that should be considered as imperfections of human performance. In musicians' opinions, the most important factor is the subjectivity of notes reading and their musical language marks. In sound engineers' view, the all-important factor is slightly mis-intoning of pitch and accidentally uneven sound attacks. Though the musicians are trying to perform strictly according conductor's directions and they are trying to play with a perfect intonation, there are numerous examples of millisecond offsets and differences in Hertz. The conductors claim that the most important factor is natural caesura between bars or musical phrases. A conductor forms this element of interpretation and these are the main features for creating his style. The fourth hypothesis states that: H4: Music performed by acoustic instruments is more coherent sonically.

A fast tempo of film music in an action film accelerates chase scenes. Those scenes without music would be perceived as slower and less dynamic. In the bicycling sequence from *Jules et Jim* directed by François Truffaut, music affected the sensation of motion and tempo of the scene. Claudia Gorbman in *Unheard Melodies: Narrative Film Music* conducted an intellectual experiment where she altered a single aspect of music layers[10]. For example, if the key was changed from major to minor in that

[8] Annabel J. Cohen "Film Music From the perspective of cognitive science", Chapter 5 in David Neumeyer, *The Oxford Handbook of Film Music Studies*, Oxford University Press 2014, p. 98.

[9] Annabel J. Cohen "Film Music From the perspective of cognitive science", Chapter 5 in David Neumeyer, *The Oxford Handbook of Film Music Studies*, Oxford University Press 2014, p. 98.

[10] Claudia Gorbman, *Unheard Melodies: Narrative Film Music*, BFI Publishing, Indiana University Press, Bloomington & Indianapolis, London 1987, p. 16-17.

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bicycling sequence, it would be received by the audience as sadder and darker. When one changes the tempo to faster and articulations to more *staccato,* the audience receives it as optimistic or even funny. If the instruments are changed to:

a. Violin solo, it would be received as more pathetic,
b. Tuba solo, it would be received as more comic,
c. Large orchestra, it would be received as more romantic[11].

Based on these statements, the fifth hypothesis was set up. H5: Music performed by acoustic instruments does not change the tempo of the scene of the film.

L.B. Meyer in *Emotion and Meaning of Music* described that musical stimuli are not standard, and are not burdened by meanings, non-notional[12]. Music accompanying a film could be both: an illustration as well as a counterpoint to the scene of the film. It is a complementary layer in the film. Film music could feature the character and reinforce the heroes' psychology or their mood. It can also might build tension or calm the scene. A live orchestra is able to transfer the emotions related to the scene of the film because musicians perform a score that is prepared to reinforce emotions. Film music composers realize that their music must complement and strengthen the power of dialogue[13]. Therefore our assumption is as follows. H6: Music performed by acoustic instruments transfers the emotions related to the scene of the film better.

4. System of organizational terms as a methodological foundation for the research

The ontological assumption of the system of organizational terms is that every fact in the organizational reality can be represented by the organizational term. The organizational term is a symbolic object, which can be used as an element of the organizational reality model (Rios, 2013). The organizational term is a close analogy to a physical quantity in the SI unit (length, mass, time etc.). It is assumed that the organizational terms are abstract objects, which are used to represent the facts which appear in the organizational reality. When the organizational term appears, it can be changed quantitatively, qualitatively, mereologically, and substantially.

The philosophical foundation of the system of organizational terms is based on Wittgenstein's philosophy: his theory of facts and "states of facts" (Brink & Rewitzky, 2002). According to this approach managerial actions can be organised by events and things. Specifically, as shown in Figure 1, each event and thing have the label n.m, in which n and m represent a number and a version of a thing, respectively. Event 1.1 causes thing 1.1, which in turn releases event 2.1 that creates thing 2.1. Thing 1.1 simultaneously starts event 3.1 which creates thing 3.1. Then, thing 3.1 generates a new version of the first event, i.e. event 1.2. In such a way, a new version of the first

[11] Claudia Gorbman, *Unheard Melodies: Narrative Film Music*, BFI Publishing, Indiana University Press, Bloomington & Indianapolis, London 1987, p. 17.
[12] Leonard B. Meyer, *Emocje i znaczenie w muzyce*, PWM, Kraków 1974, p. 36-37.
[13] David Lewis Yewdall, *Dźwięk w filmie. Teoria i praktyka*, Wydawnictwo Wojciech Marzec, Warszawa, p. 472.

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thing is created, which is called thing 1.2. Hence, the managerial action structure consists of, e.g. event 1.1 and thing 1.1.

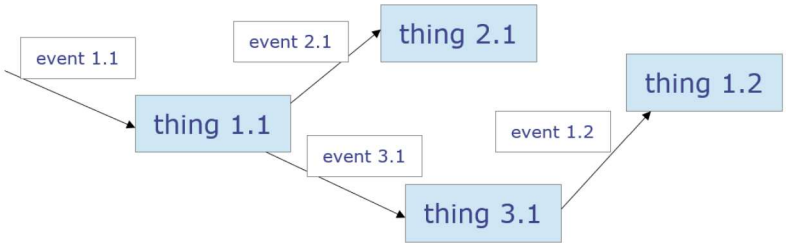

Figure 1. Fundamental structure of managerial actions

Source: Own elaboration

As it was mentioned above, features of organizational terms are grouped in time, content and human relation domains. They show how two items differ from one another or one item differs from itself in the function of time. Such an approach to ontology of human action sit lets all human activities be represented by standardized features vectors with data grouped in time, content and human domains (Flak, Yang & Grzegorzek, 2017).

In order to gather such data about human actions, one of the epistemological assumptions of the system of organizational terms is that the main research method is an objective long-term observation (Midgley, 2003). As it is shown in Figure 2, when a man thinks (action represented by Event 1.1 - *inspiring 1.1* and Thing 1.1 - *idea 1.1*), the research tool records features of *idea 1.1* in time, content and human relations domains. If later (e.g. after setting a goal – *setting 1.1* and *goal 1.1*) this man thinks more about the idea, he launches the next *inspiring 1.2* which results in *idea 1.2*. Then the features of this item are changed and represent the second version of this item (*idea 1.2*). The difference between features of *idea 1.2* and *idea 1.1* let us reason on the cognitive processes which occurred in this period of time (Flak, 2013).

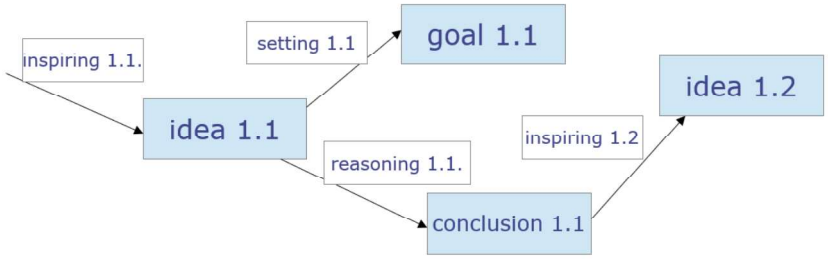

Figure 2. The example of creating resources by processes in the organizational reality

Source: Own elaboration

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The research tool records changes in items marked with blue colour in Figure 2. It resembles making a movie of human actions with frames of different features of items called things which are results of events.

Using this data we designed a research tool called NoteToday (notetoday.pl) which was a simple notepad available in a web browser. The innovative feature of this notepad was the fact that whenever a respondent made a comment in NoteToday about the movies being watched during the research and clicked Save button, next "frame" of his thoughts was created in database. None of the frames was deleted, so we could recognize all chains of thoughts marked by the Save button in the time line. Figure 3 presents a dashboard of that research tool.

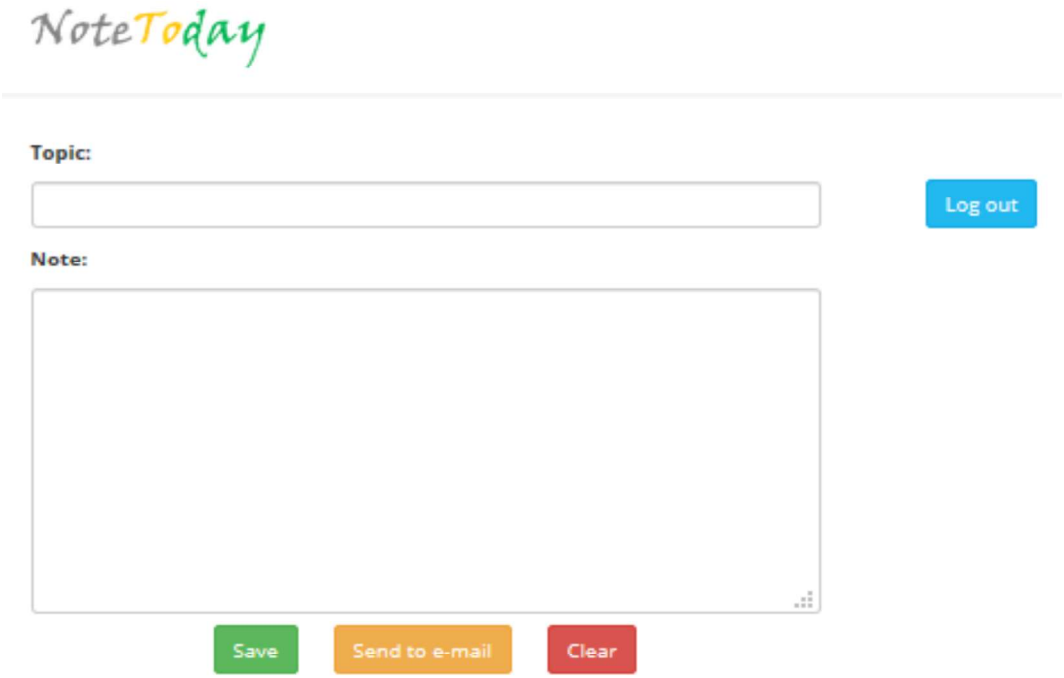

Figure 3. The example of creating resources by processes in the organizational reality

Source: Own elaboration

5. Research organization

The group of respondents consisted of University of Silesia students (Krzysztof Kieslowski Faculty of Radio and Television, Katowice) who were watching and assessing a piece of a movie with the original soundtrack (played by session musicians) and the soundtrack created using virtual instruments. The choice of the group was not random: it was composed of students who train their sensibility of film art perception, furthermore they acquire skills and abilities that are necessary in the process of film production and postproduction. They are also cinema aficionados, capable of making professional judgment of artistic work quality in the field of their profession. They were aged between twenty and twenty four.

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The research was conducted in the screening room at the Silesian University Krzysztof Kieślowski Faculty of Radio and Television in Katowice. Two film clips were identical in terms of the moving picture, but two different soundtracks were used. The first soundtrack contained the original track which was recorded by the London Symphony Orchestra during the sound postproduction stage of making "Star Wars Episode IV: A New Hope". The second track used the recording prepared with virtual instruments. The famous 40 second- long scene presented twice during the test is known as "Binary Sunset".

There were four sessions of the research conducted with the same audience, however, the number of participants differed in each attempt. In every session two pieces of the movie were shown in such a succession:

- 9th of January 2019 (first the video clip with the original soundtrack, then the clip with the soundtrack created with virtual instruments) – 35 respondents,
- 16th of January 2019 (first the video clip created with virtual instruments, then the clip with the original soundtrack) – 41 respondents,
- 23th of January 2019 (both video clips with the original soundtrack) – 19 respondents,
- 30th of January 2019 (both video clips with the soundtrack created with virtual instruments) – 14 respondents.

It is necessary to note that the respondents did not know the succession of clips, neither did they realize that the clips would be accompanied by different types of instruments. They were also unaware of the exact goals of the research.

After watching the first video clip, the participants of the research were writing their impressions in the NoteToday tool answering 6 questions which fitted the hypotheses mentioned in Section 2. The questions were as follows:

- In which of the viewed video clips music was more emotional? (H1)
- In which of the viewed video clips music was more connected with the video content? (H2)
- Did any element of music disturb your attention in the scene of the viewed video clips? (H3)
- In which of the viewed video clips music was more consistent sonically? (H4)
- In which of the viewed video clips did you have the impression that the action was faster? (H5)
- In which of the viewed video clips music better reflected emotions associated with the scene? (H6)

Subsequently, after watching the second video clip, they answered the same six questions. The time for completing the survey was unlimited.

6. Results of the research

The results of the research can be presented in two dimensions: (1) the perspective of different sessions and respondents' answers to the research questions and (2) the perspective of 6 research questions in different sessions of the research.

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First, the perspective of different sessions and respondents' answers to the research questions are shown in Figures 4, 5, 6, 7, 8, 9. Numbers on the x line in Figures (from 1 to 4) represent the numbers of sessions as follows:

1. first the video clip with the original soundtrack, then the clip with the soundtrack created with virtual instruments,
2. first the video clip created with virtual instruments, then the clip with the original soundtrack,
3. both video clips with the original soundtrack,
4. both video clips with the soundtrack created with virtual instruments.

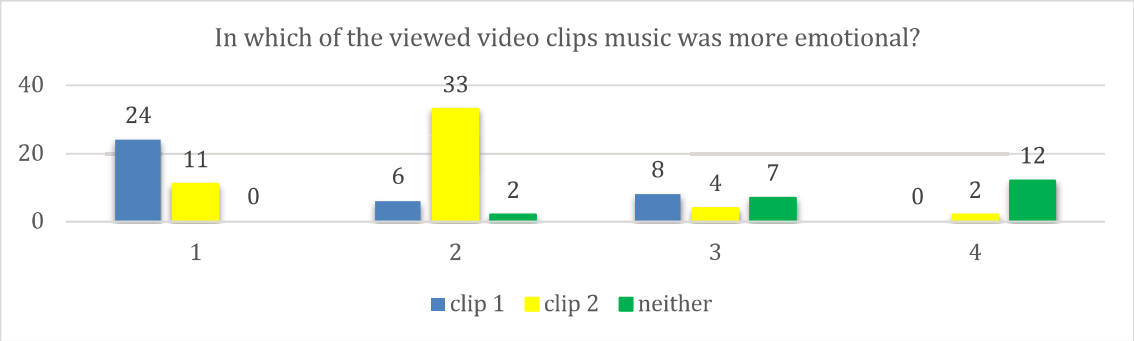

Figure 4. In which of the viewed video clips music was more emotional?

Source: Own elaboration

As it is presented in Figure 4, in the first session when the first clip was an original soundtrack, most of respondents (24 of 35 present) pointed that this clip was more emotional comparing to the virtual instrumental soundtrack. What is more, in the second session the sequence of soundtracks was reversed and the audience could hear the difference once more – 33 respondents claimed that the orchestra was more emotional than virtual instruments. 6 respondents presented opposite opinion. In the third session both clips were presented with artificial music performance. Fewer students took part in this session. They were a little confused and 7 respondents did not know which clip was more emotional.

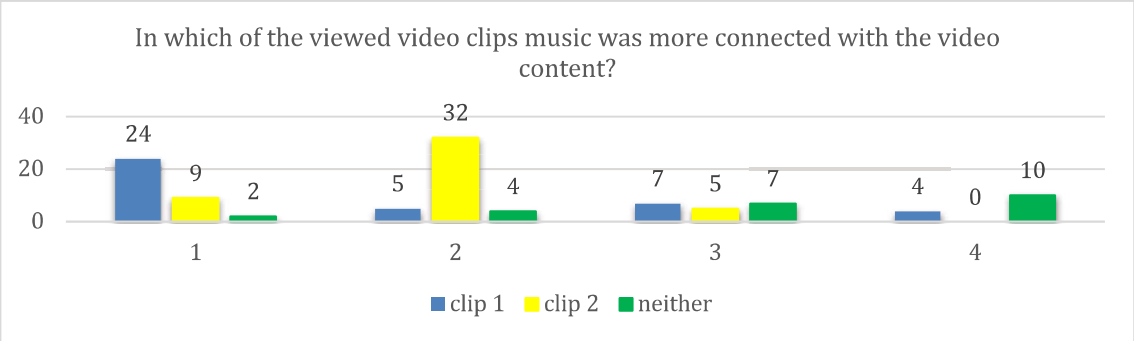

Figure 5. In which of the viewed video clips music was more connected with the video content?

Source: Own elaboration

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Figure 5 presents the answers to the issue of relations between video and music in movies. In the first session it was claimed that music was more connected to the video in the orchestra version. This perception was repeated after reversing the clips in the second session. Respondents still felt the performance with natural instruments as more connected to the movie scenes. (32 out of 41 respondents). What is interesting, in both sessions (third and fourth) the impressions were more balanced. No matter which clips they were presented with: two natural sound clips or two artificial ones, they were confused and did not point any significant difference.

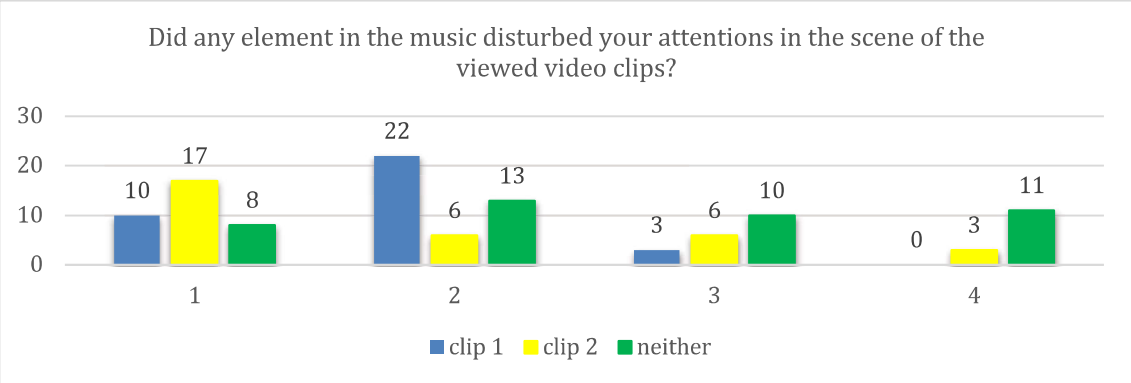

Figure 6. Did any element of music disturb your attention in the scene of the viewed video clips?

Source: Own elaboration

Results of the research presented in Figure 6 showed that a real orchestra sounds better than virtual instruments. In the first session most respondents pointed the virtual instruments as annoying (17 to 10). In the second session, when the first clip's music was performed by virtual instruments, the difference was even more significant (22 to 6). Again, in the last two sessions, when the clips had the same type of performance, respondents tried to guess and the answers seemed random.

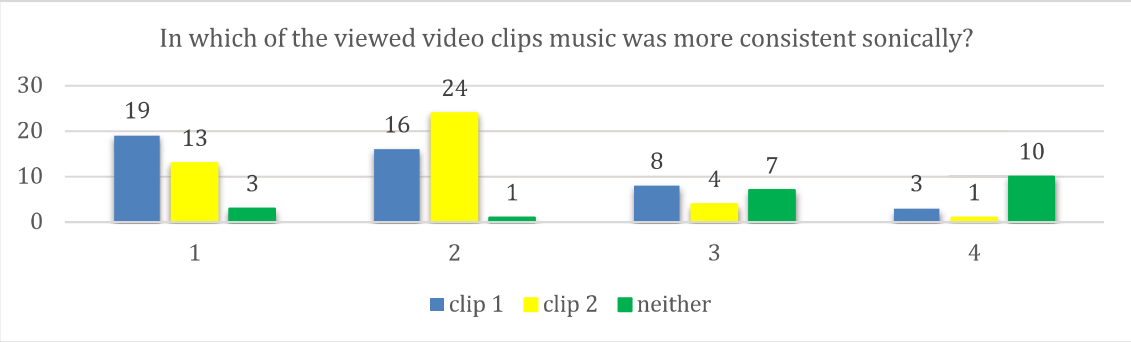

Figure 7. In which of the viewed video clips music was more consistent sonically?

Source: Own elaboration

Answers to the next question are presented in Figure 7. The question concerned the sonic consistence of the presented clips. The results are similar to the previous questions – natural instruments performance was treated as more sonically consistent

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(the first session – 19 to 13, the second session – 24 to 16). In this issue respondents were again uncertain of their feelings while listening identical clips.

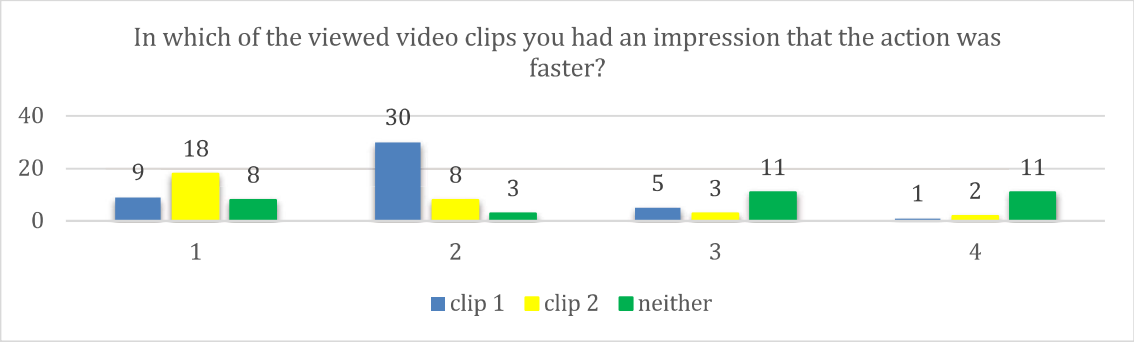

Figure 8. In which of the viewed video clips did you have the impression that the action was faster?

Source: Own elaboration

In Figure 8 we present answers concerning a subjective influence of the type of performance (natural vs virtual instruments) on subjective speed of film action. What is really interesting, virtual instruments make the action faster than the orchestra. The results were confirmed in the first and second session – the order of instruments did not matter. The difference is significant – 18 to 9 and 30 to 8. In the last two sessions respondents were completely confused – most of them did not know or did not even try to guess which clip had faster action.

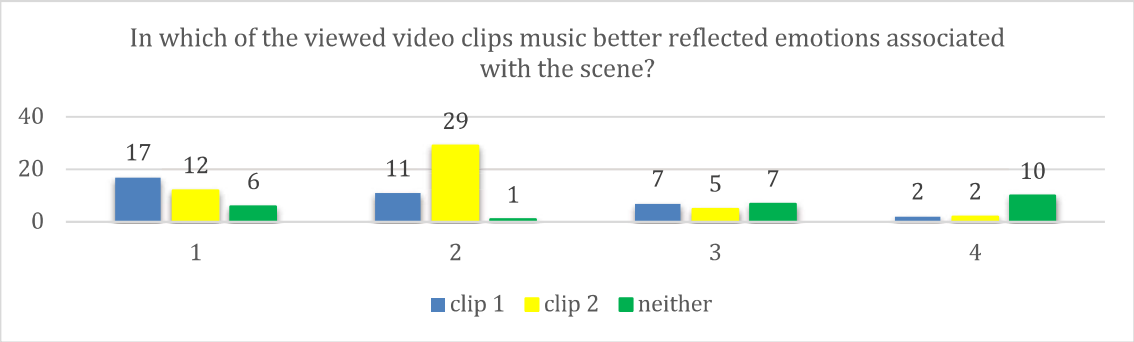

Figure 9. In which of the viewed video clips music better reflected emotions associated with the scene?

Source: Own elaboration

In the last examined issue – the level of emotions reflected by music in the scene – again the natural performance by orchestra was pointed as more emotional and associated with the scene. It was clearly confirmed by the two first sessions. Two last sessions again misled the respondents and they were unable to recognize this influence and answered by random.

Taking into consideration the answers in Figures 4, 5, 6, 7, 8, 9 we could verify the hypotheses stated in the Introduction in a way:

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- H1: Music performed by acoustic instruments that are a part of the orchestra is more emotional – true,
- H2: Music performed by acoustic instruments is connected to the film more strongly (than music performed by virtual instruments that are imitating the orchestra) – true,
- H3: Music performed by acoustic instruments is less distracting for the audience from the scene of the film – true,
- H4: Music performed by acoustic instruments is more coherent sonically – true,
- H5: Music performed by acoustic instruments does not change the tempo of the scene of the film – false,
- H6: Music performed by acoustic instruments that are a part of the orchestra transfer the emotions related to the scene of the film better – true.

Secondly, in the perspective of the 6 research questions, the answers, recorded by the NoteToday, can be found in Figures 4, 5, 6 and 7. Every Figure represents different session of the research. Numbers on the x line in Figures (from 1 to 6) represent the numbers of sessions as follows:

1. In which of the viewed video clips music was more emotional?
2. In which of the viewed video clips music was more connected with the video content?
3. Did any element in the music disturb your attention in the scene of the viewed video clips?
4. In which of the viewed video clips music was more consistent sonically?
5. In which of the viewed video clips did you have the impression that the action was faster?
6. In which of the viewed video clips music better reflected emotions associated with the scene?

Figure 10 and Figure 11 confirm the verification of hypotheses which was presented above. If the respondents were listening to different clips (acoustic instruments and virtual instruments or reversed), they were able to distinguish the difference in performance very easily. Although there were some respondents who did not recognize the types of performance, the majority of respondents, no matter in which session, could confirm that the virtual instruments sound different than acoustic ones. It is necessary to emphasise that the respondents were not presented with the purpose of the research and they were not instructed that the performance would have a different source.

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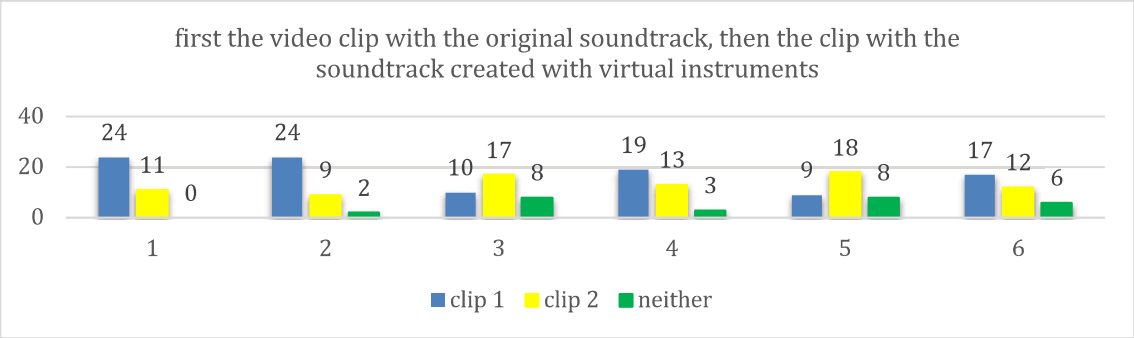

Figure 10. First the video clip with the original soundtrack, then the clip with the soundtrack created with virtual instruments

Source: Own elaboration

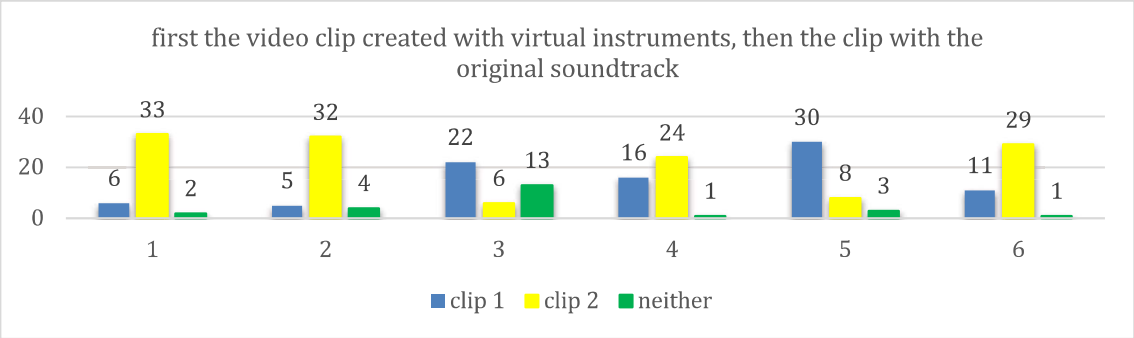

Figure 11. First the video clip created with virtual instruments, then the clip with the original soundtrack

Source: Own elaboration

Some interesting results are shown in Figure 11 and 12, as the respondents were totally confused while listening to identical clips one after another, no matter if they were accompanied by virtual or acoustic instruments. They did not point any significant differences in such cases. It proves that the results presented in Figure 9 and 10 and the verifications of the hypotheses are valid.

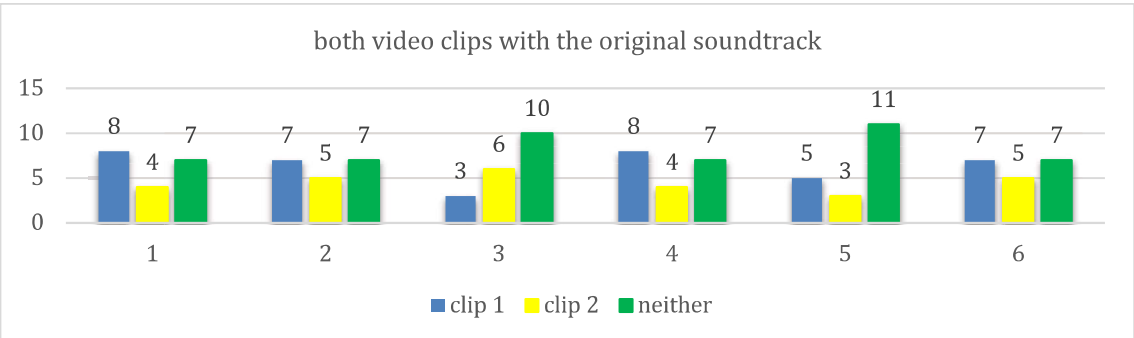

Figure 12. Both video clips with the original soundtrack

Source: Own elaboration

e-ISBN: 978-975-561-504-2

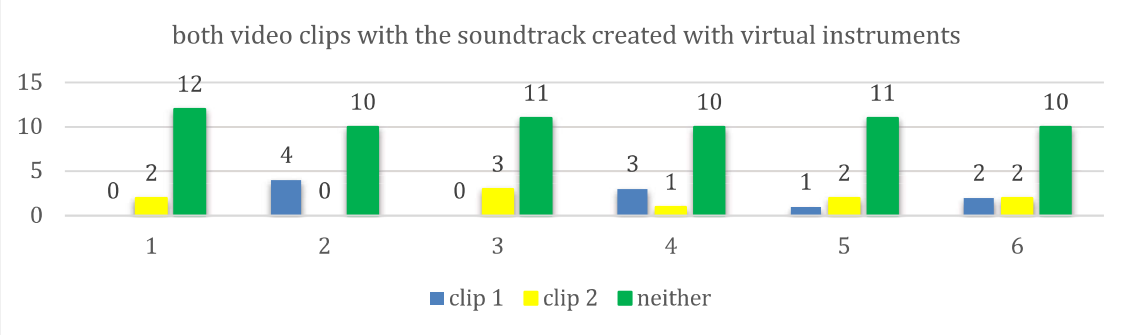

Figure 13. Both video clips with the soundtrack created with virtual instruments

Source: Own elaboration

7. Conclusions

Five of the six assumed hypotheses were confirmed by results of the research. Direct comparison of two soundtracks proved that respondents recognized which of them contained authentic material recorded during a session and which piece of music was generated by virtual instruments. The discussed results are a signal for composers that virtual and acoustic instruments should not be juxtaposed in one clip. However, composers' work shows that virtual and acoustic instruments can be joined in one clip simultaneously, like in case of Hans Zimmer's music. Certainly, music produced with virtual instruments is low-cost. That is the reason for these tools to become more popular in future.

Artificial intelligence (AI) in creating convincing soundtrack with virtual instruments could be applied in future research. AI might be used in tracking human imperfections in music performance. Moreover, the imperfect elements would be compared and the results of these analyses could be used to create a credible music clip.

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