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DOI 10.5937/kultura2277111J

УДК 781.6:069(497.11)

Оригиналан научни рад

Датум пријема: 18. 01. 2023.

Датум прихватања: 22. 3. 2023.

EFFECTS OF APPLIED MUSIC
ORIGINALLY COMPOSED FOR MUSEUMS
ON VISITOR EXPERIENCE

RESULTS OF A PILOT STUDY IN THE MUSEUM OF SCIENCE AND
TECHNOLOGY IN BELGRADE

Abstract: Originally composed music for museum applications (synomusic) is an innovative approach in presenting museum exhibits and attracting audience. However, its use is underdeveloped and the same is evident for related researches. Our pilot research aimed to explore the effects of such music on visitor experience in the Museum of Science and Technology in Belgrade. The study included surveys before (silent condition, SC) and after (music condition, MC) applying music in the museum spaces (N = 310 in total), as well as in-depth interviews in MC (N = 22). The results showed that the original, applied music improved the general experience of museum visits. The music, seen as an inseparable element of the experience, worked in interaction with the exhibits and the venue to liven up the experience, make it fuller and improve visitors' impressions. The effects of originally composed music for MNT permanent collection were identified in all three domains of the psychic process: emotional (improved visitors' moods), cognitive (awakened the memory, curiosity and the desire to spread the knowledge) and motivational (inspired play and action). The effects have manifested across all research groups, which notably also included the visually impaired museum visitors.

Key words: *applied music, background music, museum audience/visitors, aesthetic experience, emotional experience, effect of music on memory*

INTRODUCTION¹

The applied music as a genre is well developed in the theatre and movies², but its use in galleries and museums is an unexplored area. While the applied music in all those art fields has some common elements (such as being a background of mainly visual/narrative stimulations), the application of music in museums is specific compared to movies and theatres, so the results cannot be transferred straightforward from one area to another. For example, movie music follows the narrative emphasizing the specific atmosphere in specific moments, while museum music needs to ‘cover’ the entire space, following all the different rhythms and paths of visitors strolling in this space.

Notably, composing music for museums is still an uncommon practice and could be considered as a new approach to audience development³. However, the museums had not been silent all the time. The *mouseion* from Alexandria (about 300 B.C.) was dedicated to the muses, especially emphasizing music and poetry. In our era, music appeared sporadically in museum exhibitions during the 19th and the 20th century. In the 21st century, accelerated development of information technologies, with the growing need for new neurological sensations, called for development of new applied music that could complete the museum experience for museum visitors. Furthermore, in the age of digital technologies, many people now fulfil their cultural needs online – for example, they browse museum exhibits and exhibitions on social networks and websites, with neither the need nor the habit to visit museums physically. Therefore, applied music in museums could have the power to both enrich the content on social networks and other digital platforms (3D, VR, AR, and AI)⁴, and to attract more people to visit museum and fully experience the live exhibitions.

Today, a growing number of museum professionals claim that the sound is becoming an increasingly important element in planning and designing of museum exhibitions⁵. Numerous studies have argued that the sound should become an integral element of museum exhibitions, because it encourages the participation, interaction and experience

1 The project is financially supported by the Ministry of Culture and Information. The project was led by the Center for Applied Music in collaboration with the Museum of Science and Technology and the Institute for Cultural Development Research.

2 Cohen, A. J. (2010) Music as a source of emotion in film, in: Juslin, P. and Sloboda J. (eds.) *Music and emotion* (pp. 879–908), New York: Oxford University Press; Reay, P. (2004) *Music in Film: Soundtracks and Synergy*, Auckland: Wallflower Press; Thomas, T. (1997) *Music for the movies*. Los Angeles, CA: Silman-James Press.

3 Марковић, А. В. и Јокић, Б. (2022) Синомузика – примењена музика за галерије и музеје. Ка новом моделу развоја музејске публике и презентацији музејског садржаја, *Flogiston* br. 30, str. 381-396.

4 Jovanović Simić, J. i Marković, A. B. (2021) Razvoj i primena rendgen tehnologije kod Srba od Tesle i Pupina do danas, Izložba u Muzeju Nauke i Tehnike, Beograd, od 27. 10. 2021. do 30. 12. 2022.

5De Vischer, E. (2018) “Resonant Bodies” the Albert and Victoria Museum Gallery. Retrieved from: <https://www.vam.ac.uk/research/projects/sound-in-museums-new-engagements-new-tool-new-audiences>; Wiens, K. and de Vischer, E. (2019) How do we listen to museums? *Curator The Museum Journal*, 62(3), pp. 277-281.

in transmitting cultural information to visitors⁶. Furthermore, such studies have also indicated that the current practices using sound as an expressive means to convey messages, animate exhibits and stimulate visitors' attention could be improved, critically examined, and even transformed by the closer adherence to specific characteristics of sound as a special modality of cultural communication⁷.

UNDERLYING MECHANISMS: WHY TO EXPECT EFFECTS OF MUSIC ON VISITOR EXPERIENCE?

Since the applied music in museums has not been studied extensively, some insights into the underlying mechanisms could be found in studies on the effects of music on emotional and cognitive processes in general, and especially in studies on background music effects in other fields of art (e.g. movies), having in mind all the specifics of the contexts mentioned above.

A general conclusion of one such meta-analysis is that the background music has a slightly positive effect on the behaviour and emotional experience and a slightly negative effect on the memorization processes⁸. In addition, a recent meta-analysis has shown negative effects of the background music on memory and language-related tasks, but has also emphasized that such effects were identified for difficult (but not easy) tasks, and in introverts (but not extroverts)⁹. In other words, the main problem in a meta-analysis is a variety of research contexts and tasks, as well as insufficient number of comparable studies.

For example, besides negative effects of music on memory¹⁰, there are also studies revealing positive effects on working memory performance¹¹. It is important to note that a

6 Bubaris, N. (2014) Sound in museums – museums in sound. *Museum Management and Curatorship*, Vol. 29 (4), pp. 391-402.

7 Stocker, M. (1995) Exhibit sound design. *Museum International* 47(1), pp. 25–28; Lupone, M., Lanzalone, S., Gabriele, A. and De Luca, M. (2015) *Forme Immateriali* by Michelangelo Lupone: structure, creation, interaction, evolution of a permanent adaptive music work. Proceedings, EAW2015 a tecnologia ao serviço da criação musical.

8 Kämpfe, J., Sedlmeier, P. and Renkewitz, F. (2011) The impact of background music on adult listeners: A meta-analysis. *Psychology of Music*, Vol. 39, No. 4, p424–448. <https://doi.org/10.1177/0305735610376261>

9 Cheah, Y., Wong, H. K., Spitzer, M. and Coutinho, E. (2022) Background Music and Cognitive Task Performance: A Systematic Review of Task, Music, and Population Impact. *Music & Science*, Vol. 5, <https://doi.org/10.1177/20592043221134392>

10 Fassbender, E., Richards, D., Bilgin, A., Ihompson, W. F. and Heiden, W. (2012) VirSchool: The Effect of Background Music and Immersive Display Systems on Memory for Facts Learned in an Educational Virtual Environment, *Computers and Education*, Vol. 55, pp. 490–500; Christopher, E. A. & Shelton, J. T. (2017) Individual differences in working memory predict the effect of music on student performance, *Journal of Applied Research in Memory and Cognition*, Vol. 6, No. 2, pp. 167–173; Musliu, A., Berisha, B., Musaj, A., Latifi, D. and Peci, D. (2017) The Impact of Music in Memory, *European Journal of Social Science Education and Research*, Vol. 4, No. 4, pp. 222–227.

11 Mammarella, N. Fairfield, B. and Cornoldi, C. (2007) Does music enhance cognitive performance in healthy older adults? The Vivaldi effect. *Aging Clin Exp Res*, Vol. 19, No. 5, p394-9.

later study used Vivaldi's *Four Seasons*, reminding of the famous "Mozart effect" (i.e. where listening to Mozart's music can boost cognitive performance¹²), again indicated that complexity of research and task-related variables can moderate the results. There are also studies indicating positive effects of music on memory tasks, emphasizing the role of the music characteristics (e.g. rhythm, familiarity, etc.).¹³ Similarly, a recent review of papers dealing with the effects of background music on learning has shown inconclusive results, emphasizing a variety of interventions and recommending more rigorous research methods¹⁴. However, research studies on film music seem to have more conclusive results, indicating both (favourable) effects of the music on emotions as well as on remembering film scenes.¹⁵

It is not quite clear how and why the music impacts certain types of psychological processes. Unlike the "Mozart effect" which indicates direct effect of music on cognitive performance, another possible explanation is that music affects through arousal and mood, as suggested by the arousal and mood hypothesis¹⁶. Other studies also found positive effects of music on emotions and mood regulation¹⁷, and also that listening to (pleasurable) music has yielded in an increase in dopamine, the so-called hormone of happiness¹⁸.

Putting everything back into the perspective of a museum space, some positive effects of music could be expected as found in previous studies, such as one conducted in a contemporary art museum, where visitors had observed an abstract painting and listened to a background music provoking different emotions (happy, sad, peaceful, scary) or silence¹⁹.

12 Rauscher, F. H., Shaw, G. L. and Ky, K. N. (1993) Music and spatial task performance, *Nature*, Vol. 365, p. 611.

13 McElhinney, M. and Annett, J. M. (1996) Pattern of Efficacy of a Musical Mnemonic on Recall of Familiar Words over Several Presentations, *Perceptual and Motor Skills*, Vol. 82, No. 2, pp. 395–400; Purnell-Webb, P. and Speelman, C. P. (2008) Effects of Music on Memory for Text, *Perceptual and Motor Skills*, Vol. 106, No. 3, pp. 927–957.

14 De la Mora Velasco, E. and Hirumi, A. (2020) The effects of background music on learning: a systematic review of literature to guide future research and practice, *Education Tech Research Dev*, Vol. 68, pp. 2817–2837.

15 Boltz, M., Shulkind, M. and Kantra, S. (1991) Effects of background music on the remembering of filmed events. *Memory and Cognition*, 19(6), pp. 593–606; Eschrich, S., Münte, T. F. and Altenmüller, E. O. (2008) Unforgettable film music: The role of emotion in episodic long-term memory for music. *BMC Neuroscience*, 9 (48); Parke, R. Chew, E. and Kyriakakis, C. (2007) Quantitative and visual analysis of the impact of music on perceived emotion of film. *Computers in Entertainment*, 5 (3); Pavlović, I. and Marković, S. (2011) The effect of music background on the emotional appraisal of film sequences, *Psihologija*, 44(1), pp. 71-91.

16 Thompson W. F., Schellenberg E. G. and Husain G. (2001) Arousal, mood, and the Mozart effect. *Psychol Sci*, Vol.12, No. 3, pp. 248-251.

17 Sloboda, J. A. and O'Neill, S. A. (2001) Emotions in everyday listening to music, in Juslin, P. N. and Sloboda, J. A. (eds.), *Music and emotion: Theory and research*, Oxford University Press, pp. 415–429. Saarikallio, S. and Erkkilä, J. (2007) The role of music in adolescents' mood regulation, *Psychology of Music*, Vol. 35, No. 1, pp. 88–109.

18 Nadler, R.T., Rabi, R. and Minda, J. P. (2010) Better mood and better performance. Learning rule-described categories is enhanced by positive mood, *Psychol Sci*, Vol. 21, No. 12, pp. 1770-1776.

19 Braun Janzen, T., de Oliveira, B., Vantorim Ferreira, G., Sato, J. R., Feitosa-Santana, C. and Vanzella, P. (2023) The effect of background music on the aesthetic experience of a visual artwork in a naturalistic environment. *Psychology of Music*, Vol. 51, No. 1, pp. 16–32.

In short, the music valence and the music likability significantly affected the experience of the painting itself.

Other studies showed that music has inspired museum visitors to spend more time in the museum²⁰. It seemed to give positive emotional and cognitive experience: light music evoked warm and relaxed feelings in participants, while a song from the 1930s evoked feelings of nostalgia and curiosity to learn more about the songs.

CURRENT STUDY

It is particularly important to emphasize that past research studies in museums were carried out on the topic of use of popular and classical music composed for other occasions, while the current paper presents results of a project that went one step further: exploring the effects of original, specifically composed applied music to the content of the exhibits and permanent exhibitions at the Museum of Science and Technology in Belgrade. The project included composing three original music scores for the permanent exhibition of the MST in three separate exhibition spaces²¹.

This approach to applied music is conditioned by the museum exhibits themselves. Also, the length of the composition depends on the size of the exhibition space and the average time it takes a visitor to tour the exhibition space. Applied music for museums, which we labelled “synomusic”²², is composed in such a way that it has no beginning and no end and is played continuously in a loop, from the opening to the closing of the museum. The music is supposed to create a more beautiful and pleasant atmosphere for visitors and, metaphorically speaking, to “bring the exhibits to life” and make them communicate with the visitors. The artistic role of such music is to create a singular environment, where the music connects the museum exhibit, observer-consumer and the museum space into a whole.²³

From the research perspective, it is important to emphasize that the MST project was designed primary as an art project, while the research dimension was additionally designed to gather preliminary data for future research studies on larger samples.

20 Chia-Li Chen and Chen-Gia Tsai (2015) The Influence of Background Music on the Visitor Museum Experience: A Case Study of the Laiho Memorial Museum, Taiwan, *Visitor Studies*, Vol. 18, No. 2, pp. 183-195; Brenner, B. (2016) *Does music matter for museums? Understanding the impact of music*, Master Thesis, University of Washington, retrieved from <https://digital.lib.washington.edu/researchworks/handle/1773/36368>.

21 See the details of the project in: Марковић, А. В. и Јокић, Б. (2022) Синомузика – примењена музика за галерије и музеје. Ка новом моделу развоја музејске публике и презентацији музејског садржаја, *Flogiston* br. 30, str. 381-396.

22 Марковић, А. В. и Јокић, Б. (2022) Синомузика – примењена музика за галерије и музеје. Ка новом моделу развоја музејске публике и презентацији музејског садржаја, *Flogiston* br. 30, str. 381-396.

23 Марковић, А. В. (2005) *Синтезија 01, Музика за изложбу: Дислокације: утопијски простори*, (9:40), Галерија ОЗоне у Београду, Градска галерија у Смедереву и Културни центар у Сопоту, од 25. 12. 2005. до 20. 03. 2006.

The current study aimed to explore the effects of originally composed music on visitor experience in museums: 1. General impressions about the museum visit and possible contribution of the music to that experience; 2. Emotional experience – how visitors felt during the visit; and 3. Effects on memory – whether and in which way the music has affected memorization of museum exhibits.

It is important to note that the museum visitors, in general, evaluate their visits positively. It means that the effects of the applied music were not easily measured in quantitative ways (i.e. with or without music, the visit was expected to be evaluated positively). Still, we did expect that the music would affect experience in some (qualitative) way, making it specific and different from visiting museum in silence.

It is especially important to emphasize that our study also included a group of visually impaired museum visitors, driven by our wish to explore if the applied music would contribute by any means to making the museum experience more accessible and immersive to this group. On the one hand, we were interested in hearing about their experience, given their potential higher sensibility and performance in audio tasks²⁴. On the other hand, we also expected some general impressions about the music in museums being universally valuable for all visitors, regardless of their abilities or competences.

METHOD

Given that the study was composed as a pilot, exploratory study, we planned a mix method approach combining survey (pre- and post- music conditions) and semi-structured interviews, to collect not only numerical data, but also to get some deeper insights by interviewing representatives of different groups (segmented by age and expertise, including visually impaired persons).

Sample

The survey included 310 participants in total (144 before and 166 after music was introduced in the MNT). We planned a simple random sample. However, the circumstances differed under silent conditions (SC) and music conditions (MC). MC mode also included an attractive and musically enriched special exhibition²⁵, which could have impacted the results. There were more organized group visits in the MC mode, which specifically included student groups. Besides, SC was mainly during the summer, when museums are less frequently visited in general, while MC was in the autumn, when interest in museum visits is generally higher, which might have also impacted the results of the current study.

24 Wan C. Y., Wood A. G., Reutens D. C. and Wilson, S. J. (2010) Early but not late-blindness leads to enhanced auditory perception, *Neuropsychologia*, Vol. 48, pp. 344–348; Bogusz E., Koprowska H. and Skrodzka E. (2012) Investigation of performance in selected psychoacoustic tasks by visually impaired children and teenagers, *Acta Physica Polonica A*, Vol. 121, No. 1A, pp. 13–18.

25 Jovanović Simić, J. i Marković, A. V. (2021) Razvoj i primena rendgen tehnologije kod Srba od Tesle i Pupina do danas, Izložba u Muzeju Nauke i Tehnike, Beograd, od 27. 10. 2021. do 30. 12. 2021.

Again, it is very important to note that the project was primarily designed as an artistic project, while the research dimension was additionally designed to collect preliminary data for future research on larger samples.

In addition to the survey, twenty-two in-depth interviews were conducted in the MC mode. Representatives of different age groups were interviewed (three respondents from each group: young people up to 18 years old, adults 35-65 years old and retired people 65+), as well as from the professional public (a total of six respondents from the groups of composers, art historians and curators). The visually impaired group included four respondents aged 13-16 years, and three adults (including a school music teacher).

Instruments (description of variables)

A specifically designed questionnaire for the pre-music and post-music surveys contained several sections. Apart from the current study aims, the instrument also referred to internal goals of the MST officials to learn more about their audience (e.g. frequency of visiting the MST, obstacles for more frequent visits, intentions for future visits, whether they came alone or in company, who with etc.). In this section, we have described variables relevant for this study.

1. Socio-demographic data (gender, age categorized in groups 15-17, 18-30, 31-45, 46-65, 66 and older; education operationalized as the last finished level of education/school: elementary school, high school, BA, MA, PhD; employment status: high school students, university students, employed, unemployed, retired)
2. Frequency of visiting the MST (at least four times a year, two to three times a year, once a year, once in several years, current visit is the first one)
3. General impressions on the current visit (“How much did you like this visit to the MST in general?”; “How much were you impressed and ‘got into the story’ during the visit?”; “How much are you satisfied by the atmosphere in the museum?” – all in Likert scales from 0=not at all, to 10=very much)
4. A list of attributes to describe the aesthetic emotional experience (participants checked the attributes that reflected their experience²⁶)
5. Memory of exhibits: participants were asked to recall up to ten items from the current visit

The semi-structured interview also had several sections, as part of the larger study, but here we focused on those relevant for the current study: general impressions on the MST visit and impressions about the music (general impressions, emotional experience, how the music fits the museum space and exhibits).

26 Selected list from: Schindler, I. Hosoya, G. Menninghaus, W. Beermann, U. Wagner, V. Eid, M. et al. (2017) Measuring aesthetic emotions: A review of the literature and a new assessment tool. PLoS ONE, 12(6).

Procedure

Quantitative data were collected from mid-July to the end of September (silent condition), and from mid-October to the end of November (music condition). Questionnaires were offered in paper-pencil form by the research team members of the Centre for Applied Music. Due to the relatively small number of visitors (especially during summer), the initial plan to approach every fifth visitor and select only one member of the same group was changed. Instead, every other visitor was approached and invited to fulfil the questionnaire. A small percentage (4.5%) of visitors refused to participate, which is common for cultural participation research. However, 12.5% did not respond to more than 50% of questions, so their questionnaires were excluded from analysis. Given the sample size and characteristics, together with the notified differences in the circumstances in SC and MC, we have interpreted results with caution, providing them mainly for illustrative purposes and identifying trends that could be useful directions for future researches.

The interviews were organized face-to-face in the MST space (audio recorded), except for the two that were organized via online video call. All interviews were conducted immediately after the visit.

RESULTS

Results of the survey

Socio-demographic data. The results show that both in SC and MC modes there were more females than males, which is common for cultural participation studies, while it is interesting coincidence that the percentage of females was the same in the SC and MC (63.6%). There were more young people in MC (age group 15-17 years: 17.2%; 18-30 years: 58.5%, 31-45 years: 23.3%) then in SC (age group 15-17 years: 7.7%; 18-30 years: 18.7%, 31-45 years: 56%). Similarly, the SC and MC groups differed in the employment status, as mentioned in the Method section. In MC groups, there were more high school and university students, while in the SC groups there were more employed visitors (Figure 1).

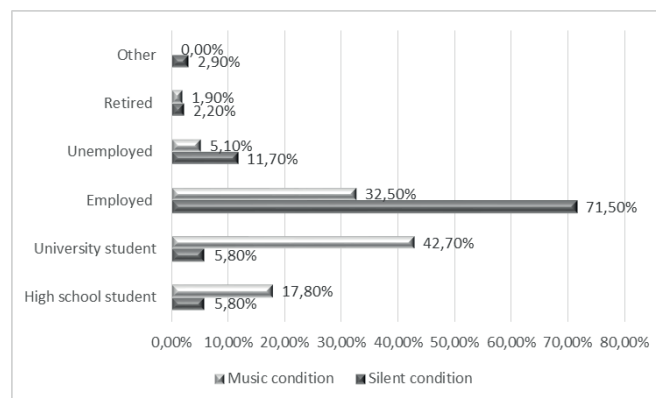


Figure 1. Sample by employment status

Education level also differed between SC and MC groups: it seems that, in the SC mode, there were more educated audiences (Figure 2), but since the question was operationalized as “the last finished level of education”, many students (58.7%) were labelled as high schoolers, while others marked higher levels of education (35% college or university, and 5.3% MA and PhD). Given those differences between samples in the SC and MC groups, we have conducted an additional control analysis on the effects of socio-demographic variables where it was meaningful.

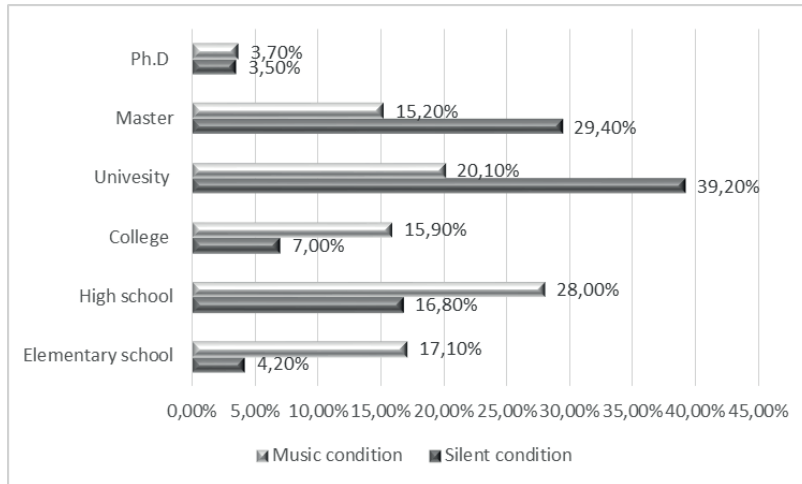


Figure 2. Sample by education level (last finished school)

Frequency of visits. A significant percentage of visitors in both SC and MC groups came to the MNT for the first time, which is a great potential for audience development (Figure 3).

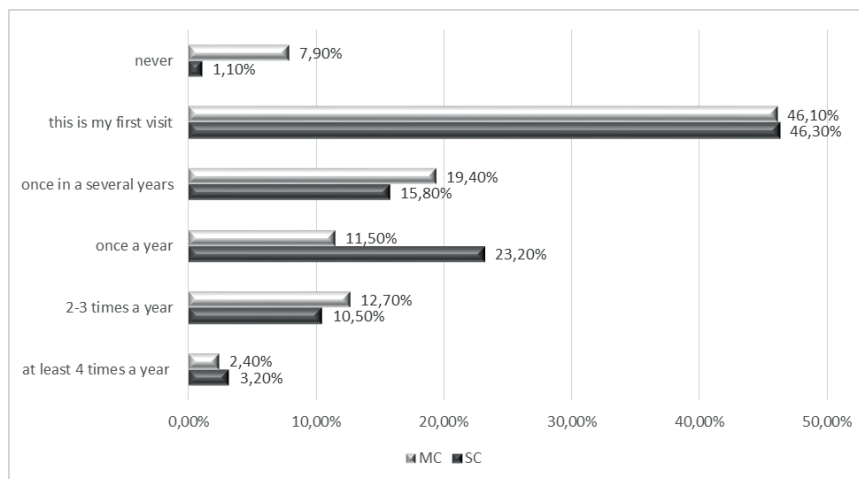


Figure 3. Sample by the frequency of visiting the MST

General impression on the museum visit. The visit to the MST was evaluated positively both before and after the introduction of music: on a scale from one to ten, the average rating is greater than eight (Figure 4). The differences in ratings before and after the introduction of music were not statistically significant, but in reply to all three questions concerning the general impression the trend was the same and leaned towards more positive ratings after the introduction of music.

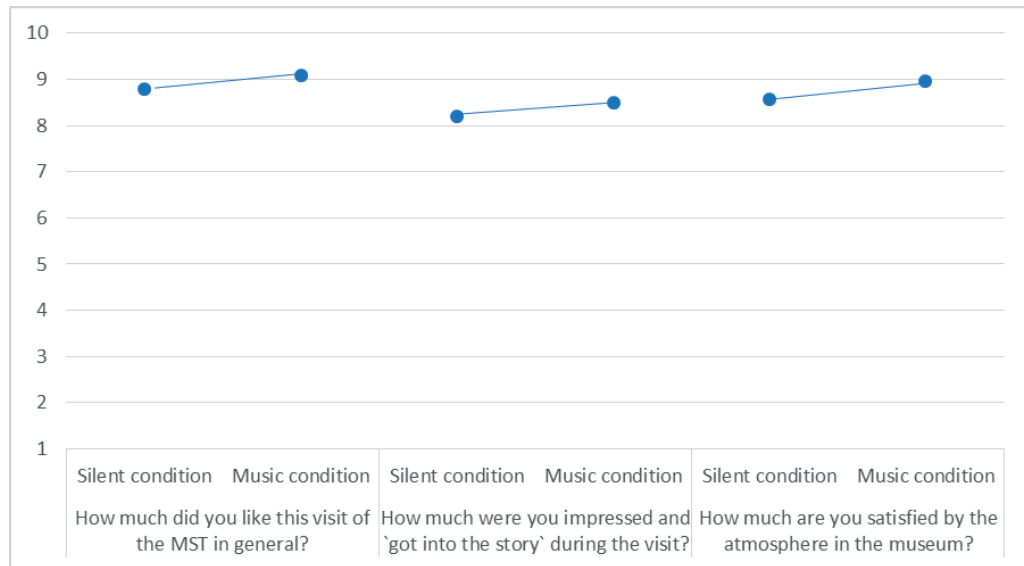


Figure 4. General impressions on the MST visit (Means are presented)

Emotional experience. In line with the results of the meta-analysis of earlier studies on aesthetic emotions, and proposing a new scale²⁷, we have selected a list of attributes and asked participants to mark those that best describe their experience in the MST. The results have shown relatively uniform descriptions emphasizing positive experiences. However, in the silent condition mode, the attributes “touched”, “happy”, “sentimental” and “nostalgic” were used somewhat more often, while in the music condition mode, those indicating a drive to action were used more often (“motivated to act”, “spurred me on”, “sudden insights”, “mentally engaged”), as well as the attributes like “surprised”, “delighted”, “fascinated” (Figure 5).

²⁷ Schindler, I. Hosoya, G. Menninghaus, W. Beermann, U. Wagner, V. Eid, M. et al. (2017) Measuring aesthetic emotions: A review of the literature and a new assessment tool, PLoS ONE, 12(6).

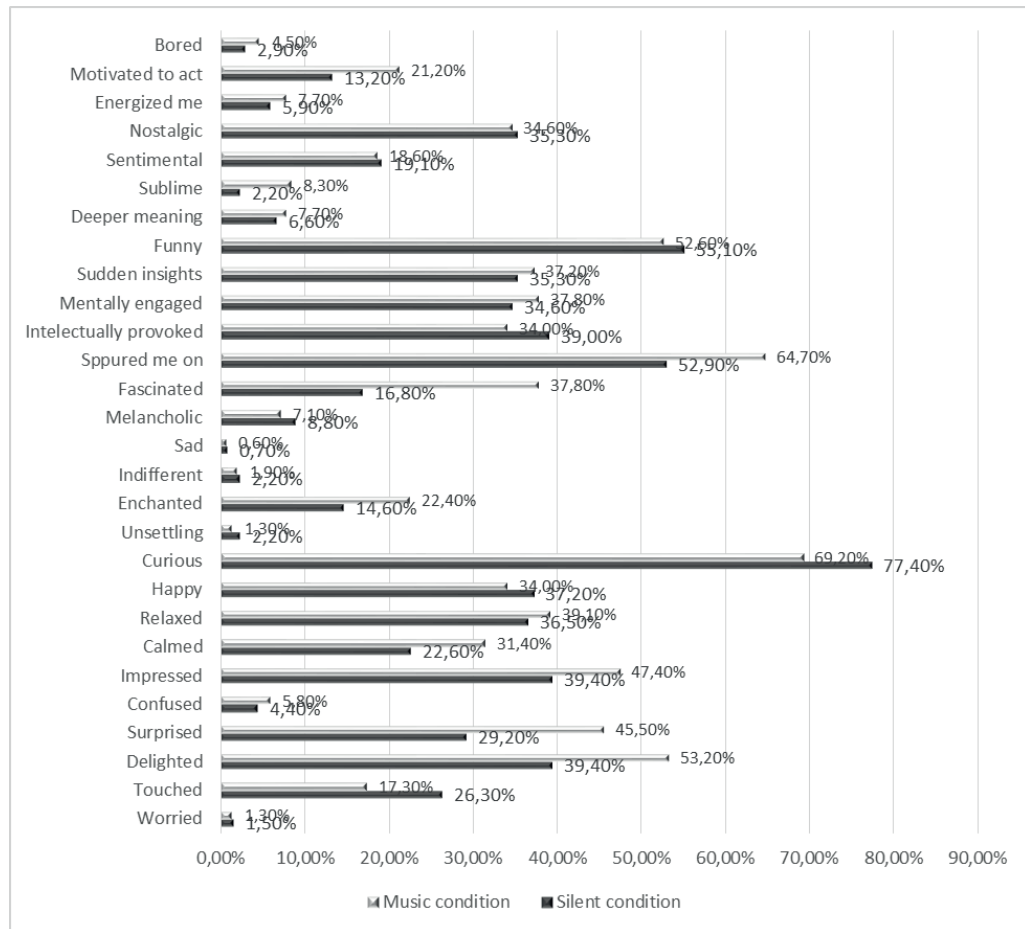


Figure 5. Description of the experience in the MST, multiple responses (selected attributes from: Schindler et al., 2017)

Memory. A higher number of museum exhibits were recalled by the group from MC mode ($M = 8.2$, $SD = 3.12$) compared to the SC mode ($M = 6.49$, $SD = 3.20$), and that difference was statistically significant $F(1, 227) = 16.381$, $p < .001$ (Figure 6). To check the interaction with age, we additionally employed ANOVA with two factors (age categories and music/silent condition), but neither age nor interaction were even close to statistical significance (for age effect, $p = .302$, while for interaction $p = .888$).

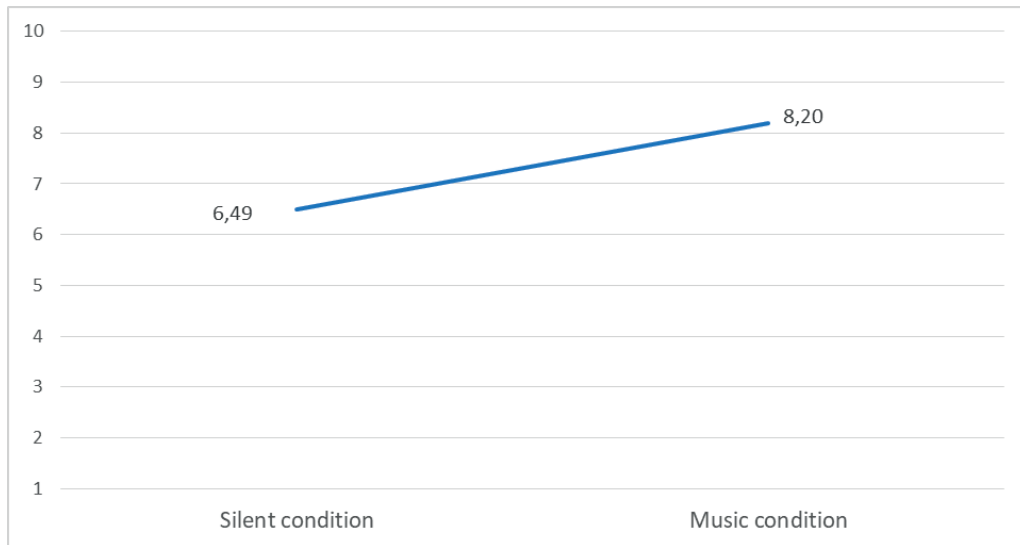


Figure 6. Number of recalled MST exhibits (out of 10 requested)

Qualitative (thematic) analysis

In general, all groups of participants had similar impressions of the music in the museum: they emphasized that the music complemented the experience by interacting with the exhibits and creating the desired atmosphere, emotions and moods in the visitors.

Music gives the space a special atmosphere that is different, it somehow moves us, gives us focus and inspires us to be in the moment, so that we don't think about other things (General population, Adults 35-65 years old).

The space is quite acoustic and the music itself sets a kind of ambient all the time. These are some specific sounds and some buzzing that is very interesting and not annoying. And the light sometimes reminds me of the Tesla lamp, it's somehow whitish-purple. Then, it all together creates a super atmosphere, a bit scientific. You look at the ceiling and you see retro lamps up there, big metal ones, that can also be seen as part of the setting (General population, Adults 35-65).

If everything were to sound perfect and fit the part I'm watching, it would be fascinating. But then again, music like that could be distracting, which is not the goal. It's clear that it can't follow everyone who looks around at all times. For example, the sounds of space were perfect for me while looking at the weights on the different planets. Even when the match was less than perfect, I had the feeling that everything was in its place (Professional public - Music).

They put together which part goes with which music. For example, the music in the playroom was different than upstairs and that's why I really liked it. Here, after all, games are everything, and then the music is different. (Young population < 18 yo).

It helps us create a whole picture in our head (Young population < 18 yo).

Although the visitors have registered the music more or less consciously, they all shared the opinion that the music should not be figural. It should not distract the focus of attention, but affect the whole experience from the background “depth”, a bit like film music.

Although there was some sound, it was in the background so I didn't even consciously register it: that's probably the point (General population, Adults 35-65).

We heard not like a melody, but sounds – robotic, various hums, hums. It's kind of just right. You notice the sound, but it doesn't disturb you and fits into the ambience. As if it holds your attention and presence, displaces you from your thoughts (General population, Adults 35-65 years).

What was important about the music that I noticed was its ambient quality, meant to complement the impression rather than being the centre of attention on its own. Music is only an accompanying element, which completes the whole story (Professional public - Music).

This music does not exist by itself, but depends on the context and the environment. People often don't notice that music the way they notice other types of music. It makes the atmosphere better on a less conscious level. Perhaps it is possible to compare it to film music. Without it, people would not feel the story and emotions. However, people do not concentrate on the music but on the action itself. And music has a constant influence (Professional public - Music).

I have an impression that when I walk through that space I don't even have to notice the music. That doesn't mean that the music doesn't exist in my head or that it didn't reach me, but that it merged super well with the environment, like a symbiosis of music and exhibits, and everything together makes that story very successful. As if it is interwoven, an integral part of it, it exists there and its place is there. (Professional public, historical art)

It is somehow soothing, to be enjoyed (Young population < 18 yo).

According to general visitors, as well as members of the professional public, the music composed and applied in the Museum of Science and Technology had no negative effects on their visit or mind sets. It was not disturbing or distracting and in no way diminishing or impairing to the experience. Also, the music was described as pleasant and ‘just right’, stimulating, but at the same time unobtrusive, ambient and zen, well-paced and suitable for a scientific atmosphere and a bit out-of-this-worldish.

The music is not loud and aggressive, but it is noticeable. It is unusual, these are not everyday sounds. However, it does not require so much concentration that it distracts you from the setting. It's just right. It has an effect similar to the Tibetan sound bowls, it induces some tranquillity and at the same time excites (Professional public - Music).

The music really complemented the whole experience both on the lower floor and on the upper one. It was beautifully chosen, as if fitting into the setting at every moment. It's

more sound effects, robotic voices, sounds reminiscent of outer space. It was changing, but all the time it was somehow flowing. The sounds are not very dynamic, they calm down and give you a pace at which you will look around, you no longer feel as if you are rushing somewhere (Professional public - Music).

The feeling evoked by the music matched the effect of the exhibition flow. The music was somewhat unpredictable, I didn't know what was to expect next, like when I look at exhibits. Those surprises raised the energy level (Professional public - Music).

In the perception of visitors, the encompassing presence of music in the space is compared to a “flowing river”, “soundscapes” or “sailing through time”.

I think the music added a lot to the atmosphere. It was abstract, meditative music. They were musical carpets, like landscapes of sound, peaceful and pleasant. You didn't notice it, but if it wasn't there you would notice the hollowness in everything. This means that it was composed properly (Professional public - Music).

The music sounds soothing, but somehow relieves that silence and emptiness. It's light, not scary like for example in the Jewish holocaust museum. The instruments are recognisable, but everything seems put together and it's like bubbling water or gentle flow of a river. In my opinion, it could be a little louder, because people here comment among themselves and read aloud. And when there is more noise, it is less audible (General population, Pensioners).

I felt like moved from reality, it took me back to that time, because that music described everything. Even while our guide was talking, everything just fell into place with the music (Young population < 18 yo)

The visitors have agreed that the applied music complements and enhances the basic moods and have stated that they were induced to feel calmness, curiosity and stepping out from everyday reality. Without the music, they would imagine the atmosphere to be more impersonal, cold and distant.

Without sound it would be boring, this way it evokes the science, like some Kraftwerk sound. Let's feel like science researchers. It fits perfectly when you see those old machines, music that represents a time machine, as if we are sailing through something (General population, Adults 35-65 years).

There was no such music in museums before, you rather entered the dead silence and looked at the exhibits and paintings. Like empty rooms. More recently, since music has been appearing in venues, it is livelier and more beautiful (General population, Pensioners).

If there was no music, everything would be cold and impersonal, like in a garage or a warehouse. The music colours it nicely, it gives some warmth to the atmosphere. With this music, we feel as if we are on home ground (Professional public - Music).

Music gives a special atmosphere to the space, which is different, somehow moves us, gives us focus and makes us present, not thinking about other things (General population, Adults 35-65 years).

Visually impaired visitors have noticed the music more than other groups, and it helped them more in completing the experience, the exhibition being more sensorial and music also filling the gaps between the exhibits, announcing the upcoming, often surprising exhibit. They also expected the sounds to be more practically related to specific objects or exhibits. On a footnote, visually impaired teenagers at few points felt the music was like “in scary movies”, being startled by sudden (and for them) contextually isolated cues.

We have no idea... until we reach a certain object to touch it, we don't know what it is. I anticipated that music would follow our path and play the sounds of the objects we touch. This music was very different and relaxing in a pleasant way. I'm really delighted. (Visually impaired population).

When I was at an exhibition before, I didn't even notice it. While walking this time I paid more attention. This was like some background that you may or may not notice. Something catches your attention and then it's more important, and the music is somewhere in the back, maybe in the unconscious. (Visually impaired population).

When we move from one theme to another, the music introduces us to a new adventure (Visually impaired population).

It was not too loud, in some moments it seemed to evoke the atmosphere of that time the objects were from (Visually impaired population).

Importantly, the group reacted positively to the inclusive aspect of this study, and told us that the sounds in museums can serve multiple purposes.

I would like to thank everyone who remembered us not only when it was the day of the white cane, the day of the disabled etc., but also for noticing us on ordinary days... You wanted to help us and adapt it so that we could also have some nice things to participate in. It means that you have considered us perhaps not as equals, but here you are to offer us the same thing as to the rest of the world (Visually impaired population).

In general, the atmosphere in the museum is phenomenal! It's honestly great! Relaxing (Visually impaired population).

I would recommend others to come, but I wouldn't tell them anything in particular. Just to relax and enjoy. And feel. (Visually impaired population).

DISCUSSION AND CONCLUSION

Applied music for museums and galleries (synomusic) remains an underexplored topic both in terms of accumulating scientific insights about its effects on emotional

and cognitive processes of visitors, and in terms of resources for audience development. The current project aimed to contribute to both areas by providing some insights and suggesting directions for future research.

The results of the current project have indicated that applied music in museums has beneficial effects on general experience of the museum atmosphere, while also relating to specific emotional experience and memorization of the content during the visit. More specifically, the music effects could be traced in all three types of psychological processes: emotional (music affected the mood in a positive and stimulating way), cognitive (recalling the museum exhibits was higher when music was present), and motivational (being moved to act).

When discussing the effects of music on emotions, it is worth mentioning that museum visitor experience is generally positive, which was also found in previous studies²⁸. Moreover, involving music into museum events is not about overcoming the unpleasant silence, but adding a new dimension of the experience. The results of the current study also showed that some positive attributes dominated in silent condition mode (such as “touched”, “happy”, “sentimental”, and “nostalgic”) while others dominated in music condition mode (such as “delighted”, “fascinated”). Also, the music condition mode involved more of those impressions moving to action (e.g. “motivated to act”, “spurred me on”, “sudden insights”, “mentally engaged”). Qualitative analysis additionally revealed visitors’ perception of music influence as a stimulation to explore, spur of curiosity, accompanied by relaxing effects at the same time.

The intention of composers to not distract the main content (perception and experience of museums exhibits) seems to have been fulfilled, since the music was generally perceived as having a background effect contributing to the general atmosphere in the museum space. The music was perceived as affecting the experience from the background; it was inconspicuous and did not distract attention but helped focusing. Moreover, the music was perceived as making a “synesthetic” unifying effect with the museum space, exhibits and visitor observers²⁹, like “a flowing river”, “sound carpets” or “sailing through time”. The attributes for describing the music were: pleasant, appropriate, stimulating, ambiental, meditative, unobtrusive, not too dynamic, suitable for a scientific atmosphere, unusual.

An interesting effect of the applied music in MST, worth to be explored further, is about the memory. While past studies showed mixed results³⁰, they also indicated that

28 Martinović, D. (2010) Muzejska publika, *Kultura*, Vol. 127, pp. 334-348; Jokić, B. i Žeželj, I. (2013) Why festival museum attendance cannot predict regular museum attendance: Examining the attitude-behavior relationship, *Kultura*, Vol. 140, pp. 445-469; Jokić, B. (2016) Predictors of intentions and behavior: Can museums’ festivals increase the popularity of museums? *Kultura*, Vol. 152, pp. 331-349.

29 Марковић, А. В. и Јокић, Б. (2022) Синомузика – примењена музика за галерије и музеје. Ка новом моделу развоја музејске публике и презентацији музејског садржаја, *Flogiston* br. 30, str. 381-396.

30 Mammarella, N. Fairfield, B. Cornoldi, C. (2007) Does music enhance cognitive performance in healthy older adults? The Vivaldi effect, *Aging Clin Exp Res*, Vol. 19, No. 5, pp. 394-399; Fassbender, E., Richards, D., Bilgin, A., Ihompson, W. F. and Heiden, W. (2012) VirSchool: The Effect of Background Music and

complex music can affect the memory by involving many moderating variables, such as music rhythm and familiarity³¹. So, a more rigorous research method is required³². While our study could also be further methodologically improved (e.g. more rigorous experimental design), the results we have obtained are quite robust indicating beneficial effects of music on memorization processes, regardless of age. Together with previously mentioned beneficial effects of music on emotions, including moving to action and mental stimulation, our results go in the direction of the arousal and mood hypothesis³³ (Thompson et al., 2001). However, more research is needed to replicate these findings.

Interviewing a group of visually impaired visitors, both adults and teenagers, was also valuable. Two insights are worth further exploring: general impressions and differences between adults and teenagers. All of them seemed to notice the music more intensely and to deem it more important for the complete experience than others. They emphasized how music had fulfilled what would otherwise be emptiness between two exhibits, somehow announcing what would happen next and making an atmosphere similar as in movies. However, teenagers noticed that the music sometimes had scary effects, “like in scary movies”, and some of them shared that it would be better if sounds were more specifically related to the exhibited objects. On the one hand, that can reflect specific teenager experiences and interests, while on the other hand, it also indicates the need for experiencing objects in a way that compensates the lack of visual information and makes them more familiar through specific sounds. That would certainly go in another direction as well, as sounds in museums do not only imply music, and their purpose can be different. For example, there is a differentiation of five possible ways of using sounds in museums: sound as lecturing; sound as an artefact; sound as ambiance/soundtrack; sound as art; sound as crowd curation.³⁴ All of them are worth further exploring, especially among visually impaired visitors.

Immersive Display Systems on Memory for Facts Learned in an Educational Virtual Environment, *Computers and Education*, Vol. 55, pp. 490–500; Christopher, E. A. and Shelton, J. T. (2017) Individual differences in working memory predict the effect of music on student performance, *Journal of Applied Research in Memory and Cognition*, Vol. 6, No. 2, pp. 167–173; Musliu, A., Musliu, A., Berisha, B., Musaj, A., Latifi, D. and Peci, D. (2017) The Impact of Music in Memory, *European Journal of Social Science Education and Research*, Vol. 4, No. 4, pp. 222–227.

31 McElhinney, M. and Annett, J. M. (1996) Pattern of Efficacy of a Musical Mnemonic on Recall of Familiar Words over Several Presentations, *Perceptual and Motor Skills*, Vol. 82, No. 2, pp. 395–400; Purnell-Webb, P. and Speelman, C. P. (2008) Effects of Music on Memory for Text, *Perceptual and Motor Skills*, Vol. 106, No. 3, pp. 927–957.

32 De la Mora Velasco, E. and Hirumi, A. (2020) The effects of background music on learning: a systematic review of literature to guide future research and practice, *Education Tech Research Dev* Vol. 68, pp. 2817–2837.

33 Thompson W. F., Schellenberg E. G. and Husain G. (2001) Arousal, mood, and the Mozart effect, *Psychol Sci*, Vol.12, No. 3, pp. 248-251.

34 Current sound-based multimodal museum exhibitions are diverse. Cortez (Cortez, A. (2022) Museums as sites for Displaying Sound Materials: A FiveUse Framework. *Sound Studies*, Vol. 8, No. 1) has recently mapped and categorized them into a five-use framework, namely: sound as lecturing; sound as an artefact;

If we go back to the music in museums, results of the current study are in line with previous research findings that background music provokes different emotions, depending on the valence and music likability.³⁵ In addition, individual differences also moderate the experience,³⁶ enabling visitors to have a specific experience in the same space listening to the same music. It is especially important to underline again that previous research was conducted on the use of popular and classical music already composed for other occasions, while current study was conducted in the ambience of specifically composed music for the MST space and for the permanent exhibition. This leaves the possibility to explore the subject further so as to check how different compositions impact visitor experience of the same museum collection and space. With only a handful of experimental examples of composing this kind of applied music for exhibitions and museums, there is a need to develop composing rules and methodology for participatory applied music, with multidisciplinary experts exploring this theme.

Limitations of the quantitative segment of the study, in terms of different circumstances (i.e. attractive special exhibition also accompanied with applied music) that have impacted sample characteristics have also revealed how innovative tools could be successful in developing audiences by attracting those with underdeveloped habit of visiting museums. That segment of audience is usually labelled as potential audience: those who have positive attitudes but lack the habit to visit certain cultural programmes – in this case museums³⁷. Unlike those who will visit museums regardless of specific attraction measures (regular museum audience/visitors) or those who are not interested in museums or even have negative attitudes (non-audience/visitors), the potential audience/visitors should be a focus of attention of museum professionals. Applied music provides one way of attracting them. It is additionally useful as it can be also promoted on social networks and other digital platforms.

On top of addressing the low level of active involvement of audiences in museum programmes, an original applied music score for museums and galleries (synomusic) could play a significant role in fulfilling contemporary needs of museums and modern museology. Introduction of a new digital and sonic atmosphere into museums and sharing of

sound as ambiance/soundtrack; sound as art; sound as crowd-curation

35 Braun Janzen, T., de Oliveira, B., Ventrone Ferreira, G., Sato, J. R., Feitosa-Santana, C. and Vanzella, P. (2023) The effect of background music on the aesthetic experience of a visual artwork in a naturalistic environment. *Psychology of Music*, Vol. 51, No. 1, pp. 16–32.

36 North, A. C. (2010) Individual Differences in Musical Taste, *The American Journal of Psychology*, Vol. 123, No. 2, pp. 199–208; Garrido, S. and Schubert, E. (2011) Individual Differences in the Enjoyment of Negative Emotion in Music: A Literature Review and Experiment, *Music Perception: An Interdisciplinary Journal*, Vol. 28, No. 3, pp. 279–296.

37 Martinović, D. (2010) Muzejska publika, *Kultura*, Vol. 127, pp. 334–348; Jokić, B. i Žeželj, I. (2013) Why festival museum attendance cannot predict regular museum attendance: Examining the attitude-behavior relationship, *Kultura*, Vol. 140, pp. 445–469; Jokić, B. (2016) Predictors of intentions and behavior: Can museums' festivals increase the popularity of museums? *Kultura*, Vol. 152, pp. 331–349.

the new promotional model in communication of cultural heritage with audible elements with the potential audience could contribute to the development of the museum audience.

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ЕФЕКТИ ОРИГИНАЛНО КОМПОНОВАНЕ ПРИМЕЊЕНЕ МУЗИКЕ У МУЗЕЈИМА НА ДОЖИВЉАЈ ПОСЕТИЛАЦА

РЕЗУЛТАТИ ПИЛОТ СТУДИЈЕ У МУЗЕЈУ НАУКЕ И ТЕХНИКЕ У БЕОГРАДУ

Сажетак: Оригиналнo компонована примењена музика у музејима (синомузика) је иновативан приступ у представљању музејских експоната и привлачењу публике. Међутим, њена употреба је недовољно развијена, као и истраживања ефеката на доживљај посетилаца. Наше пилот истраживање имало је за циљ да истражи ефекте такве музике на доживљај посетилаца Музеја науке и технике у Београду. Дизајн студије је укључивао анкетирање пре (ситуација тишине, СТ) и после (ситуација с музиком, СМ) примене музике у простору музеја (укупно $N = 310$), као и дубинске интервјуе у СМ ($N = 22$). Резултати су показали да је оригинална примењена музика унапредила општи доживљај музејске поставке. Музика, која се сматра неодвојивим елементом доживљаја, описана је као да делује у интеракцији са експонатима и простором како би оживела доживљај, учинила га потпунијим и побољшала утиске посетилаца. Ефекти музике компоноване за сталну поставку музеја испољили су се у сва три домена психичких процеса: у емоционалним (поправља расположење посетилаца), когнитивним (буди памћење, радозналост и жељу за ширењем знања) и мотивационим (подстиче на игру и акцију). Ефекти се манифестују у свим групама, посебно у групи посетилаца музеја са оштећеним видом.

Кључне речи: *примењена музика, њозадинска музика, музејска њублика/њосејшиоци, есејеско искусејво, емоционално искусејво, усејицај музике на њамћење*