New perspectives in didactic music games: Using synesthetic resources in an educational music minigame

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Abstract

Characteristics of synesthesia have been recently implemented as a resource in digital games. However, there is a limited number of games designed for music education that use synesthesia. This phenomenon allows us to expand perspectives in different types of games and create complex relations and dynamic interactions between game and player. The intention of this research was to investigate the importance of the use of this phenomenon in the context of games for music education. In this work, different uses of synesthesia in arts are presented, specifically in the musical arts and in some music methods that use these characteristics. Also, some digital games, considered as popular, that use different characteristics of synesthesia as an essential feature will be examined. Then, it will be discussed if the number of music games intended for music education is sufficient or not. For this, the methodology includes content analysis of literature and videos on the subject. This, to find some relations between the concept of synesthesia and its use in digital games. Finally, some examples of uses of synesthesia in games will be contextualized in a music digital minigame proposal for music education, that uses the relation between color and sounds.

Keywords: music education, digital games, synesthesia, digital music games.

Introduction

Have you ever smelled something and remembered a place? Or, have you ever eaten something and thought of someone? These characteristics have to do with the phenomenon called synesthesia. Although "there is still ambivalence and debate about the essential criteria that define synesthesia" (Lynall, 2013, p. 959), we can say that for some people there is an innate possibility of mixing senses: vision, smell, taste, hearing, and touch as a response to different stimuli. This phenomenon, known as synesthesia, "comes from the Greek *syn*, together, and *aisthesis* of perception" (Morrison, 2000, p. 37). The study of this subjective phenomenon is related to how the mind coordinates the interaction of two or more senses simultaneously. The experience of synesthesia can be induced by stimuli and sensations like shapes, food, touching things, being in pain, among others. Being such a complex phenomenon, not all people know they have synesthesia, which can manifest itself consciously in some people only, and at different levels, according to Cytowic (2008):

It has been argued that: "synesthesia is actually a normal brain function in every one of us, but that its workings reach conscious awareness in only a handful… In synesthesia, a brain process that is normally unconscious becomes bared to consciousness so that synesthetes know they are synesthetic while the rest of us do not" (Cytowic, 2008,

p. 166). Therefore, there may be people who are synesthetic and who do not know it, and people who could still develop synesthesia or synesthetic characteristics.

This phenomenon has been studied and described by science, by authors in the field of neuroscience such as Rouw and Scholte (2007) and Kadosh et al. (2005), and authors in the field of psychology such as Karwoski and Odbert (1938), among others. The psychological and biological understanding of synesthesia, as well as its dissemination in the media, has allowed to extend this idea to the development of applications, software, and games.

When talking about digital game development, one of the main goals is for a player to become immersed in the game (Pichlmair, Kayali, 2007). For Csikszentmihalyi, for example, the immersion is related to the flow experience that he defined as an exceptional moment that occurs when "what we feel, what we wish, and what we think are in harmony" (Csikszentmihalyi, 1997, p. 29). Also, for Ermi and Mäyrä's, immersion is defined as "becoming physically or virtually a part of the experience itself" and "that takes over all of our attention, our whole perceptual apparatus" (Ermi, and Mäyrä's, 2005, p. 4). In either case, immersion is a time when a person feels totally involved in an activity.

When talking about education, there are some activities or tools that can help us in the teaching and learning process. One of these activities is using technology and games. The resources used for video game development and creation have evolved over time. Sound has evolved, as well as visuals and imaging in digital games, and all these developments have allowed us to work with perception more engagingly and has allowed immersion more efficiently. These developments in technology bring new ideas like using synesthetic resources in digital games, which has been gaining strength in the last years with the rapid evolution of computer and imaging technology, creating interfaces that can interact in much more complex ways with players and surroundings.

This work presents ideas of synesthesia in the arts and synesthesia in digital games, which could be implemented in music digital games. Finally, the design of a minigame for music education, specifically for music memory and music score reading, is presented.

Background literature

Synesthesia in the arts

In the arts, we can observe different kinds of synesthesia applied. One common type happens when emotions are related to corporal senses and colors. Poets often use this resource to express their ideas. For example, it can be noted in Rimbaud's poem "Vowels" (1871) the close relation between colors and letters, "A black, E white, I red, U green, O blue: vowels" (Duffy, 2013, p. 2). Rimbaud also makes a relationship between a sense and an action: "A, black velvety jacket of brilliant flies which buzz around cruel smells" (Duffy, 2013, p. 2), the smell being cruel.

Like poets, there are examples of visual artists and musicians for whom synesthesia has influenced their creative process and become an essential part of their work. According to Kevin Dann, "various artists who produced highly creative works, Kandinsky, Rimbaud, and Scriabin, were inspired in synesthesia" (as cited in Martino, Marks, 2001, p.62), experimenting with different types of it. Inspired by the music of

composers like Wagner, Kandinsky (1982), in his early years, discovered sound-to-color synesthesia or chromesthesia, where sounds automatically and involuntarily evoke colors:

> The violins, the deep tones of the basses, and especially the wind instruments at that time embodied for me all the power of that pre nocturnal hour. I saw all my colors in my mind; they stood before my eyes. Wild, almost crazy lines were sketched in front of me. (as cited in Van Campen, 1997, p. 3)

For Scriabin, on the contrary, the synesthesia was color hearing; in other words, listening to sounds when seeing colors. According to Galeyev (2007), synesthesia in music can also be perceived when treble sounds are related to a bright image, and bass sounds to darkness. The same occurs when teaching the musical parameter of intensity, and it is said that a loud sound is big, and a soft sound is small. This association is simple to teach and understand because of its relation to the physical world, where consistently big is heavy and small is lighter in weight. In music education, these forms are widely used to explain the ideas and characteristics of music theory more graphically. So, by using these tools, it is easier for students to relate high pitch sounds with brighter colors, such as yellow or orange, and low pitch sounds with darker colors, such as black or blue. Thus, this allows us to understand music, consciously, or unconsciously, in a synesthetic way.

Bragança et al. (2015) highlights an experiment of Wolfgang Köhler, that associates words with geometric figures for the study of synesthetic perception, called "Kiki and Booba" in Figure 1. In this experiment, people are asked to associate the names Kiki and Booba to these two figures, without knowing anything else than what they see: color and shape. One of them (in the left) is orange and with an angular shape, and the other (in the right) is purple and with round shape. The experiment's results showed that 95 to 98% of people chose Kiki for the angular shape and Booba for the round shape. Making clear, with these results, that people (not necessarily declared synesthetic) associates color, figures and words.

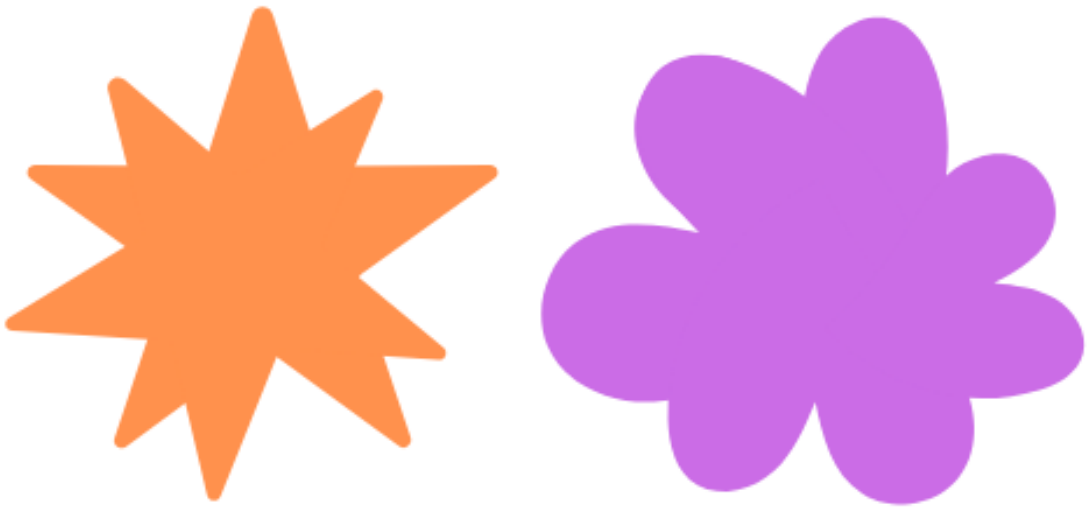

Figure 1. "Kiki and Booba" experiment by Wolfgang Köhler.

There are also methods of teaching music that uses synesthetic characteristics relating color and sound, as the example of the method called "Music in Colors", created in the 1960s by Chilean composer Estela Cabezas ("*Música en colores*", n.d), in which, a graphic system replaces traditional music writing, notation, and rhythms with colors attributed to musical notes: C blue, D green, E yellow, F orange, G red, A purple, B light blue, making, with this, music education more playful and imaginative.

Following are some ideas and examples of the use of synesthesia in digital games.

Synesthesia in Digital Games and Games for Music Education

The concept of synesthesia has not only been used in music education but also in digital games. For example, the Japanese game designer Tetsuya Mizuguchi created the game "*Child of Eden*", in 2011. This game mixes music, rhythm, colors, and movement in a rail shooter style. The game includes motion because it works with a Kinect sensor (motion sensor) for *Xbox 360*. This game was created to generate a synesthesia experience for players. The game "*Child of Eden*" makes players experiment with senses, where the music, objects, and colors used are synchronized with the player's movement and interactions with the game (TED, 2011, 04:01).

Another example of synesthesia in digital games can be seen in the game "*140*" (140 Game, 2013, 0:00–1:01). This game, developed by Jeppe Carlsen, is an experience of geometric figures, music, sounds, colors, and movement in a minimalist setting with colorful abstract graphics. In the game, it is important to have a rhythmic musical awareness to overcome obstacles controlled by an electronic soundtrack. These obstacles appear and disappear to the rhythm of the music.

We have noticed that there are digital games that use synesthesia and games that are interested in using music as its main part. Therefore, we would also like to ask what are the digital games that exist to teach music?

Some games have added music education perspectives to them, although it is not very clear if they have a real music education intention. An example of this is "*Super Mario* RPG" (released in 1996), which has a part in it where, by using a pentagram and allowing the player to write in it, it is possible to win cards to buy in-game products (*Super Mario* RPG, 2012 00:00–00:37), working, in this way, on musical skills such as pitch, reading, and memory. Another example of this is the game "*The Legend of Zelda*: Ocarina of Time", released in 1998 for *Nintendo 64*, that includes minigames in which the player has to remember a melody that is written in a pentagram, where the notes are represented by commands on the joystick (for example, X, A, L, Y, R) gaining objects to buy different items within the game (*The Legend of Zelda*, 2014, 08:02–08:32).

Thinking strictly about music education, there is one website that has been gaining popularity in the last years, and that can be accessed easily by teachers for music education, called "*Chrome Music Lab*". This platform has 13 different experiments, where the player or student can "explore music and its connections to science, math, arts, and more" (Chrome Music Lab, 2016). One important fact about this website, besides all the musical possibilities that it allows, is that characteristics of synesthesia are used in some of the modules. For example, the experiment called "Song Maker", which is a melodic and rhythmic sequencer uses the same characteristic as the music teaching method described above "Music in Colors", with the difference being that the colors used for each note are not the same. In this case, they use C red, D orange, E yellow, F light

green, G dark green, A purple, B pink, and for the rhythmic pattern, they use geometric figures: triangle and circle (“Song Maker”, 2016).

Though this website is one of the most complete for music education, there are only a few popular digital games that can establish a direct relationship with music theory that involves the player in the music experience.

It is a fact that music is a complex phenomenon and that there are still many questions about how we think and feel it. For this, music education involves many different variables that are difficult to teach, such as emotion, creativity, or sensitivity. However, with the development and use of technology for music classes, new perspectives of teaching and understandings appear.

Here we wonder how digital games and technology mixed with synesthesia characteristics could be used for a better understanding of music elements and parameters, generating active participation of students, immersion, and that could stimulate and educate musically.

In the following section, we present a general minigame model using characteristics of synesthesia for developing music memory.

Music Digital Minigame Proposal

This minigame proposal is intended as an application of digital game synesthesia to music education. It is part of a game that we are developing, for music creativity (Music Creativity Games, 2019), which comprises different musical moments that correspond with distinct characteristics of music. In this minigame, the player starts watching and listening to a melody written in a music score. The melody becomes progressively longer, as shown in the example in Figure 2 (on the top and in the middle). In order to have an interactive visual representation and a synesthetic approximation using the relation of sound and color, the notes written in the score have the same colors as the previously discussed game “Song Maker”. After having seen and heard the melody, a new screen appears where random notes, written in a score, will be falling one by one, as shown at the bottom of Figure 2. In this second screen, the player must touch the notes in the order that they appeared in the melody on the first screen. Then, the game returns to the first screen, where the melody is written, and the melody will be increased note by note, and so on. If the player chooses the notes in a different order, the game will be over, and it could be started again (access to the minigame in the link: https://gctucci.itch.io/simon-sings).

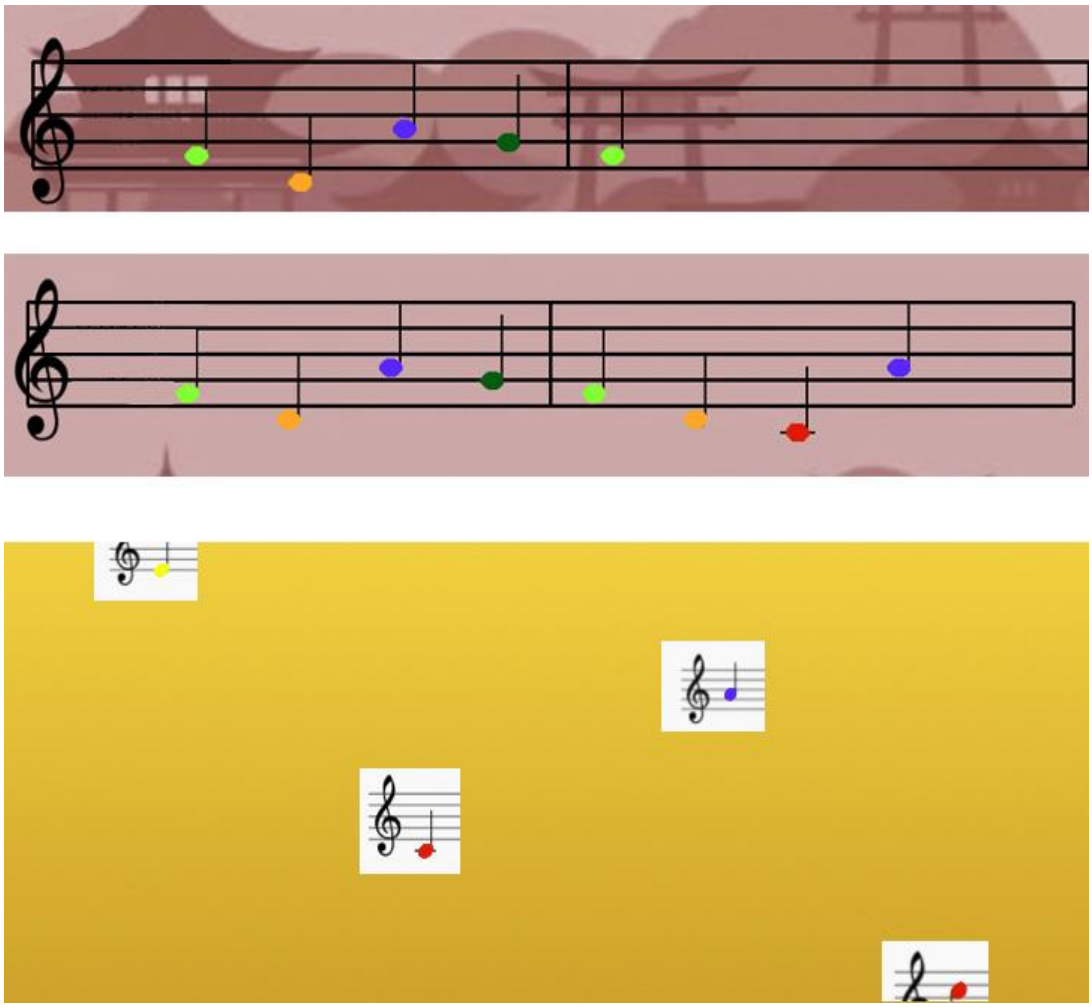

Figure 2. Minigame model. On the top, an incomplete melody written with colored notes. In the middle, the same melody but now enlarged. At the bottom, random notes falling through the screen

This idea is based on the model of the game "*Simon*" (Simon Game, 2013, 00:17–00:34), an electronic game for developing memory skills, based on a repetitive sequence of colors and sounds, where the player has to reproduce the sequence in the order given by the game, and that it increases over time. When the player fails, the game is over.

This game could be used for music education for working with memory, auditory recognition, and reading notes. With the use of colors and touching screens, new connections and understanding of music characteristics could be made.

Final Considerations

Synesthesia is a phenomenon that could be used as a resource for music education, facilitating the understanding of music. Particularly, the most common type of synesthesia, chromesthesia, could be used to associate colors with different musical structures and parameters, like pitch, harmony, melody, among others.

The proposal described in this paper can offer better interaction and immersion, because, on the one hand, the player is challenged in a playful way, and on the other hand, music theory is presented in a simple way through colors and sounds. Thus, the use of synesthesia in different arts disciplines gives us an idea of how this resource can be

interesting to use in music education. Moreover, with the inclusion of synesthesia in digital games, we can see an opportunity to consider these tools in this context.

The minigame proposed can promote the understanding of music from a perspective of immersion and connection with the senses using synesthesia, which can complement traditional music education and be a path of initiation into the world of music. Moreover, digital technology offers multiple forms of implementation, offering possible new uses of synesthesia in future game proposals.

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References

140 Game. [Game Informer]. (2013, February 14). *140 Trailer* [Video File]. Retrieved from https://www.youtube.com/watch?v=7ymLKF9Ppps.

Bragança, G. F. F., Fonseca, J. G. M., & Caramelli, P. (2015). Synesthesia and music perception. *Dementia & neuropsychologia*, *9*(1), 16–23. https://doi.org/10.1590/S1980-57642015DN91000004.

Google. (2016). *Chrome Music Lab*. https://musiclab.chromeexperiments.com/About.

Csikszentmihalyi, M. (1997). *Finding flow: The psychology of engagement with everyday life*. Basic Books.

Cytowic, R. E. (2008). *The man who tasted shapes*. MIT press.

Duffy, P. L. (2013). Synesthesia in Literature. Oxford Handbook of Synesthesia. https://doi.org/10.1093/oxfordhb/9780199603329.013.0033.

Galeyev, B. M. (2007). The nature and functions of synesthesia in music. *Leonardo Music Journal*, *40*(3), 285–288. https://doi.org/10.1162/leon.2007.40.3.285.

Kadosh, R. C., Sagiv, N., Linden, D. E., Robertson, L. C., Elinger, G., & Henik, A. (2005). When blue is larger than red: Colors influence numerical cognition in synesthesia. *Journal of cognitive neuroscience*, *17*(11), 1766–1773. https://doi.org/10.1162/089892905774589181.

Lynall, M. E., & Blakemore, C. (2013). What synesthesia isn't. In J Simner, E Hubbard (Eds.), *The Oxford Handbook of Synesthesia* (959–998). Oxford University Press.

Martino, G., & Marks, L. E. (2001). Synesthesia: Strong and weak. *Current Directions in Psychological Science*, *10*(2), 61–65. https://doi.org/10.1111/1467-8721.00116.

Música en colores. (n.d.). El método. https://www.musicaencolores.com/el-metodo/.

Song Maker. (2016). *Chrome Music Lab. Google.* https://musiclab.chromeexperiments.com/Song-Maker/song/5136166095421440.

Super Mario RPG. [BluesifulWave]. (2012, July 15). *Super Mario RPG: Legend of the Seven Stars – Melody Bay – Frogfuicius' Suite #18.* [Video]. Youtube. https://www.youtube.com/watch?v=QG_6bo6K0ts.

TED. (2011, May 21) *TEDxTokyo –Tetsuya Mizuguchi – Positive Power of Games – [English]|TED Talks* [Video]. Youtube. https://www.youtube.com/watch?v=79iXviZEWow.

Simon Game. [Marbles The Brain Store]. (2013, October 14). *Simon*. [Video]. Youtube. https://www.youtube.com/watch?v=1Yqj76Q4jJ4&t=18s.

Morrison, J. C. (2000). Hypermedia and synesthesia. In *Proceedings of the Media Ecology Association* (Vol. 1, pp. 37 –52). http://www.media-ecology.net/publications/MEA_proceedings/v1/morrison01.pdf.

Music Creativity Games (2019), *Music game for developing music creativity* [Video file]. Youtube. https://youtu.be/Pu4E7dE1-3g.

Pichlmair, M., & Kayali, F. (2007, September). Levels of Sound: On the Principles of Interactivity in Music Video Games. In *Proceedings of DiGRA 2007 Conference.* DIGRA. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.190.2004&rep=rep1&type=pdf

Rouw, R., & Scholte, H. S. (2007). Increased structural connectivity in grapheme-color synesthesia. *Nature neuroscience*, *10*(6), 792 –797.https://doi.org/10.1038/nn1906.

The Legend of Zelda. [ZeldaMaster]. (2014, December 06). *The Legend of Zelda: Ocarina of Time 3D - Part 5 - Princess Zelda* [Video]. Youtube. https://www.youtube.com/watch?v=A-GTvGmpR0w.

Van Campen, C. (1997). Synesthesia and artistic experimentation. *Psyche*, *3*(6). http://psyche.cs.monash.edu.au/v2/psyche-3-06-vancampen.html.