The "Good or Bad?" Game: Stimulating Listening Skills through Playful Engagement

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ABSTRACT

Musical listening, besides being an important form of entertainment, is particularly important for emotional engagement, affect balance and person's well-being. In this paper authors introduce "Good or Bad?", a music listening game based on the comparison of multi-track recordings. Through the use of gameful elements, challenges and score achievement, authors try to engage two players in music active listening tasks including the detection of musical features such as harmonic structure, rhythm and musical meter. The game is played by moving in the range of a large-scale responsive environment, a floor portion placed under a motion capture system which allows the tracking of one ore more people. This allows to link the players movements to audio and graphic output, producing meaningful interactions. The results of a public assessment of the game are briefly presented and discussed. The game may be used for leisure and entertainment but may also be employed both to train and to assess music listening skills.

CCS CONCEPTS

• **Human-centered computing → User interface management systems**; • **Social and professional topics → Informal education**; • **Applied computing → Sound and music computing**;

KEYWORDS

Musical games, active listening, serious games

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1 INTRODUCTION

Music listening is a widespread form of entertainment, greatly supported by the diffusion of cheap playback devices and mobile internet connection. In everyday listening the mere passive exposition to music supports a lot of cognitive and physiological functions such as implicit knowledge of complex harmonic and melodic structures [14], sensorimotor answers to regular rhythmic inputs [3], emotion arousal [8] and recovery enhancement in brain injured patients [15]. Everyday music listening is particularly important for affect regulation [16] and for the psychological well-being of the elderly [9]. In spite of this wide range of impact effects on the human brain and cognitive system, only a very little part of the interaction possibilities offered by musical listening are employed in the most popular contemporary entertainment applications. For example music is massively employed in video games, but mainly as a background element aimed at perceptual immersion, or characters connotation [20]. Also in the most popular music video games, i.e. "'Guitar Hero"[1], user interaction is very often mediated by visual input, which plays a predominant role with respect to music content. Conversely, the "Good or Bad?" game logic, presented in this paper, is deeply grounded on musical listening. "Good or Bad?" is a two player game based on a large scale responsive environment. A large-scale responsive environment is a floor positioned under the range of a motion tracking system. Computers process the data coming from the motion sensors and output the coordinates of one ore more people inside the active area, allowing thus to link the user's position to interactive audio and graphics. In the "Good or Bad?" game the users' task is to rebuild a music piece whose tracks have been mixed with those of another music piece belonging to

[1] See https://en.wikipedia.org/wiki/Guitar_Hero for "Guitar Hero" reference.

the same musical genre. The kind of musical listening required to players is defined as "active listening" because it implies that listeners control somehow the audio output by performing meaningful actions on the musical content [12]. In the case of the "Good or Bad?" game the actions performed are track selection (Player A) and decision making (Player B), as described in Section 2.1. In the remainder of this paper Section 1.1 provides an extensive review of some active listening applications and outlines the "Good or Bad?" game characteristics in this domain. The game's proceeding, active listening process, gameful elements and large-scale responsive environment are described in Section 2. Finally, some statistics about the game's demonstration during a public event with evaluations and further work perspectives are presented in Sections 3 and 4.

1.1 Active Music Listening

According to Volpe and Camurri [19] active music listening applications may be subdivided into two groups: one consisting of content-based applications and the other of user-centered applications. While for the first group the aim is providing a more creative approach to music listening, in the other the musical output depends strictly on user interaction or degree of users collaborativeness. To the first group belongs "MusicSpace" [13] where the user can manipulate the mixing of pre-recorded song audio tracks by changing the spatial position of the various instruments on a GUI interface. Masataka Goto designed many active listening applications aimed at song chorus detection [4], song navigation [5] and musical information display through a web interface [6], which all belong to the first group. In the group of user-centered applications there is "Orchestra Explorer" which relies on single user gestures to enhance the listening of a particular instrument or orchestral section [2]. The "Sync-in Team" game [10] instead is based on the coordinated interactions of many users who have to synchronize their movements to a musical beat, the rewarding score depending on the degree of synchronization they reach. Also in "Mappe per Affetti Erranti" [1], a project developed at Casa Paganini/Infomus (Genova, Italy), the musical output is linked to the collaborative behaviour of the dancers, who can influence it by moving in different zones and by changing the relationships of their movements. Materials employed in active listening applications are mainly song tracks or multitrack audio. Song tracks undergo digital sound processes like acoustic features analysis, similarities detection or digital filtering [5], whereas multitrack files are used to explore polyphonic compositions [2], or to mix tracks in a creative way (MusicSpace, INTER [5], and Sound Scope Headphones [7]). A further action allowed by multitrack recording is the song recomposition, which is made by adding the different musical layers corresponding to the various tracks one after the other until the completion of the composition. This kind of music recomposition is the task of the "Sync'n'Move" application, where the music rendering is more or less enhanced depending on the movement synchronisation of the two users. Similarly, "Sync'n'Moog" employs the spectral changes produced by a digital filter to allow the whole piece to emerge, while in "Sync'n'Mood" the parameters of music expressions (such as sound level, notes articulation and tempo) depend on users movements [18]. In these last three cases the users reward is the full intelligibility of the composition obtained through the alignment of their gestures. As an active listening application "Good or Bad?" employs multitrack audio of songs or instrumental pieces to recompose the original music. The tracks are selected by one player and then accepted or discarded by a second player always in a different order. Thus during the game process the musical listening of the composition changes depending on the number and on the order of the accepted tracks.

2 THE "GOOD OR BAD?" GAME

A non-monophonic piece of music can be seen as the superposition of different musical horizontal layers, corresponding to the various instrumental tracks (strings, brasses, woods, percussion, keyboards, etc.). For the "Good or Bad?" game authors rely on a database of couples of compositions belonging to the same musical genre organized in four layers corresponding to similar instrumental parts (track 1, 2, 3, 4 for the first piece and 5, 6, 7, 8 for the second piece) plus two tracks where the instrumental parts and the melody are merged in a complete audio rendering of the composition (track 9 and 10). Thus, each repertoire employed in the game is composed of 10 tracks, as showed in Figure 1.

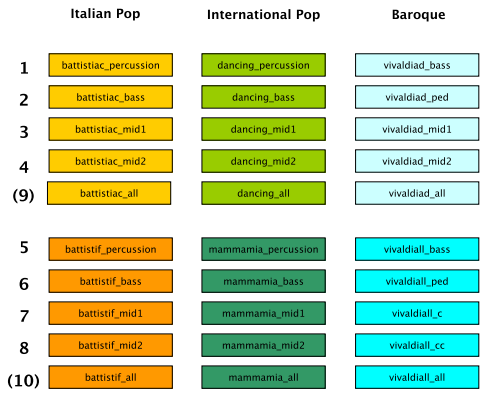

Figure 1: The three repertoires employed in the "Good or Bad?" game subdivided in couples of pieces, with the four instrumental tracks for each piece (1, 2, 3, 4 and 5, 6, 7, 8) plus the rendering tracks of the complete piece (9 and 10 in brackets).

For the present version of the "Good or Bad?" game authors have chosen three repertoires. The first is dedicated to Italian popular music and includes two songs of the italian songwriter Lucio Battisti[2], "Acqua Azzurra" (1970) and "Fiori rosa fiori di pesco" (1970); the second looks at international popular music and includes two songs of the swedish group Abba,[3] "Dancing Queen" (1976) and "Mamma Mia" (1975); the third is devoted to classical baroque music and includes two instrumental pieces taken from Antonio Vivaldi's "Le quattro Stagioni" (1723)[4], Concerto No. 1 in E major, Op. 8, RV 269, "La primavera" Allegro and Concerto No. 4 in F minor, Op.

[2]See http://www.luciobattisti.info for Lucio Battisti's reference.
[3]See http://www.abbasite.com for Abba's reference.
[4]See xhttps://en.wikipedia.org/wiki/The_Four_Seasons_(Vivaldi) for "Le quattro Stagioni" reference.

Figure 2: The floor interface for the choice of one of the three repertoires to be employed in the game.

8, RV 297, “L’inverno" Largo (in E-flat major). These choices were inspired by the popularity of the musical pieces, their simplicity and, at the same time, by the soundness of their musical structure. As the repertoires were intended for an Italian audience, authors aimed also at mixing up national and international popular styles. The choice of Vivaldi was motivated by the necessity of proposing a contrasting style and also by its wide popularity. In order not to make the comparison too simple, the pieces of each repertoire share the same key and mode (all the pieces are in a major tonality). Thus other more subtle musical qualities are involved in the track comparison, such as harmonic structure, rhythm and musical meter.

2.1 Game Workflow

The game is played by two players who move on the responsive area. At the beginning of the game the players are presented with the three music repertoires depicted in the projected image of Figure 2. By walking on the corresponding zone of the responsive floor one of the users can play each of the three pieces representing the three different repertoires proposed, and can select one of them by stepping on the number projected on the floor. When the repertoire decision is made, the playing area appears. It is divided into two zones marked by a black line, each one reserved to one of the two players, referred here as “Player A” and “Player B” in Figure 3. In the left zone are laid 8 interactive landmarks corresponding to the 8 musical tracks, which will become visible during the game proceeding. The audio tracks of each repertoire are numbered from 1 to 4 for the first piece and from 5 to 8 for the second, as depicted in Figure 1. At the beginning of each match a random sequence of numbers from 1 to 8 is generated by the system in order to assign the tracks to the interactive landmarks always in a different order. Only the first two landmarks are visible at the beginning of the match, while the others will be unveiled as the game progresses. Player A, who has the role of the track selector, walks inside one of the two blank circles that mark the first two tracks. If the corresponding track number t is $1 \leq t \geq 4$, the first composition is the reference piece and the second is the antagonist, whereas if the track number

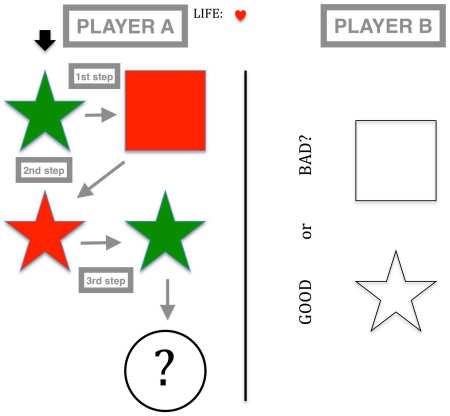

Figure 3: The projection of the playing area of the “Good or Bad?” game at an advanced stage of the game. Three tracks of the reference piece (stars) and one track of the antagonist piece (squares) are already unfolded, with only one life still available for the players because the previous choices were wrong (the red ones). The grey labels and arrows are included only in the picture but are not visible in the actual floor projection.

is $5 \leq t \geq 8$, the second piece is the reference and the first the antagonist. Thus, through a random selection, Player A determines what piece will be the reference and the antagonist. By stepping in the blank circle the player enables the first track to play on the left channel of the stereo audio system, while the blank circle becomes a green star. No actions are expected from the players but to listen to the music for 10 seconds. After time expires a new series of blank circles appear to invite player A to make a new selection. When done the new track plays at a louder volume on the right channel of the audio system. Player B, who has the role of the decision maker, now is called in the game. The "Good?" and "Bad?" buttons appear on the right side of the responsive floor, inviting player B to decide if the track belongs or not to the reference piece. If the answer is right the position occupied by player A becomes green, a written message "GREAT :)" appears on the floor and a jingle plays. If the answer is wrong the position occupied by player A becomes red, a written message "WRONG :(" appears on the floor and a disapproval jingle plays. Player B's answer is also processed for life calculation. If the answer is right players save their life, otherwise, the life is lost. Players win if they manage to unlock all the 4 tracks of the reference song without losing more than the 3 lives given at the beginning of the match, otherwise they lose the game[5].

2.2 The Active Listening Process

To help listeners in the evaluation process, authors employ an audio stereo system with fixed audio volumes. The left channel plays at a lower level and is used for the reference piece; the right channel plays at a louder level and is used for the track to be evaluated. When the first track is selected, it is played in loop on the left audio channel, while the second track to be evaluated is sent to the right channel. After Player B has decided if this track belongs to the reference piece (i.e. has voted "Good") or not (i.e. has voted "Bad"), the track is sent in any case to the left channel and played in loop together with the first if it belongs to the reference piece, or, otherwise, it is discarded. Thus the reference tracks gather in the left channel where they are played at a lower volume, while the track proposed for evaluation stands alone in the right channel at a higher volume. In the example of Figure 3 are depicted the effects of three phases of the game:

(1) First step: the first track of the antagonist piece (the red square) is evaluated against the track of the reference piece (green star). Players B's answer is wrong, the antagonist track is discarded and the square becomes red. One life is lost.
(2) Second step: the first reference track is still playing on the left channel playing and now is evaluated against another reference track (the red star). Again player B's answer is wrong and the star becomes red. The track is not discarded but is added to the first reference track playing on the left channel. A second life is lost.
(3) Third step: a new reference track (green star) is evaluated against the two reference tracks already unfolded. Player B's answer is now correct and the life is saved. The listening condition of this comparison is now different from the previous step because the new track is not compared against one but against two reference tracks. This actually changes the perceptual balance of the evaluation because the tracks to be evaluated will be more easily assigned to their group, as the effect of the disturbing (or according) track will be more effective in this condition. This perceptual process is based on the well known figure-ground auditory segregation, that is the human hearing system's ability to detect an emerging acoustical figure against a background of other simultaneous elements [17].

[5] An example of the game can be seen in this video https://youtu.be/XEliaFxKGeQ

2.3 Gameful Elements

To increase users engagement in the music listening task required by the "Good or Bad?" game, authors employed some gameful elements in the game design. These elements include interactive graphics effects and sound elements that are set in response to users actions.

(a) **Interactive landmarks labels.** The 8 interactive landmarks that correspond to the musical tracks in the left part of the active floor depicted in Figure 3 take a different color and shape depending on the different phases of the game. At the beginning of the match appear only 3 blank circles. As soon as the first choice is made, the chosen landmark takes the form of a star, which indicates the reference piece. While a new track has to be evaluated the blank circle displays a question mark in the middle. After the Player B answer has been given, the landmark may take the form of a star (the track belongs to the reference piece) or of a square (the track belongs to the antagonist piece). The color depends on whether the answer is right (green) or wrong (red).
(b) **Feedback to player B's answer.** To notify if the answer of player B is right or wrong, two different jingles play after the answer has been given, one for approval and the other for disapproval. Also two different written messages and emoticons appear on the floor.
(c) **Victory of defeat notification.** Victory is notified with the playback of the whole reconstructed song and with a written congratulations message. Defeat is marked with an ironic repeated verbal expression.

These elements have been designed to increase the users' fun while playing the game and, a the same time, to help them to understand the game logic.

2.4 The Large-scale Responsive Environment

The architecture of the large-scale responsive environment employed for the game is schematised in Figure 4.
The system employs 4 PCs and 2 motion tracking devices (Kinect v2) connected to a local Gigabit Ethernet network. The tracking system is based on OpenPTrack [11]. This software was chosen for its robustness to occlusion and to not ideal lightening conditions as well as for its scalability (up to 10m) in view of future expansions of the game floor. The two Kinect v2 are directly attached to a computer running Ubuntu Linux OS which analyses the data and detects the

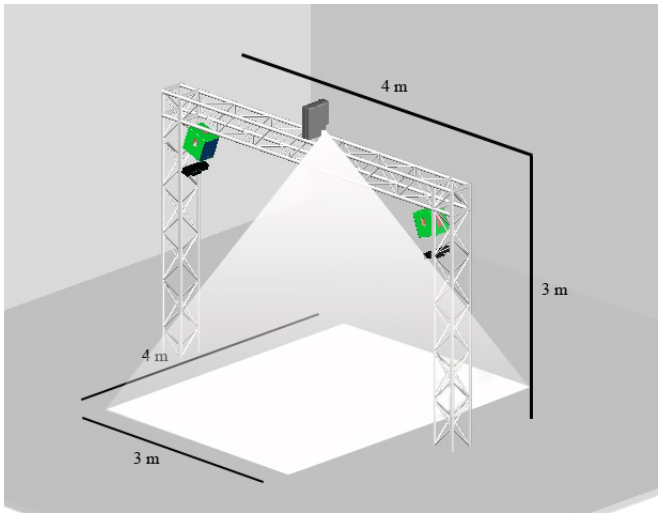

Figure 4: The large-scale responsive environment of the “Good or Bad?” game with the aluminium truss, the floor projector, the two audio monitors of the stereo system (in green) and the two Kinects mounted immediately below.

people. These data are sent through the network to the Master PC that merges them into a global tracking output. The track of the moving centroids of the people is provided via UDP using JSON-formatted packets. The packet stream is managed by the “Good or Bad?” application (running on the Master Machine) that use the coordinates of every person as input sources. This application is developed using the framework Processing 3.0 beta[6] and it is also connected to a MAX/MSP[7] patch that controls the audio output. The visual output is projected on the floor in a 4x3m game field by a single projector placed on the top of a truss. During the execution the application collects all the experimental data necessary to evaluate the user experience such as the progression of the unfolded music track, the choices of the players and the permanence time for every phase of the game (turn length).

3 ASSESSMENT

The “Good or Bad?” game has been evaluated during a public exhibition in Padova (IT). Access to the installation was open to any kind of audience from the early childhood to middle-aged people. The game was installed in a room of 7x8m, with a reverberation time $RT_{60} = 1.2s$. The original floor was covered with a white carpet of 3x4m, in order to improve the chromatic contrast of the projected images. The system was kept on for 7 hours without any restart and reconfiguration, thus showing good software and hardware robustness and stability. 150 people have been involved in the game with a total of 120 matches played. More than 60% of the users asked to play more than one match and among them about 30% played with all the 3 repertoires. In general users enjoyed the experience and showed no difficulty in understanding the game logic and the interaction mechanism. However, only 99 of 120 matches were completed, because some users abandoned the match session before the end: mainly they were very young children who enjoyed the interactive graphics but who could not understand and take part in the complex gameplay.

Statistics about the completed matches are reported in Table 1 and 2, which show a general uniform distribution of data among the three music repertoires, with an average of 65.5% of overall successful matches. The Chi-square statistic reports no significant difference of victories and defeats among the 3 repertoires as showed in Table 2. The data of Table 1 evidence also similarities in the match and in the turn length. Particularly, the turn length (that is the time spent by the users in the evaluation of the new track) is nearly the same for every repertoire and it is rather short in relation to the average duration of the song excerpts. This means that, in general, the behavior of the users tends to be indifferent to the music repertoire. Conversely, even within the same repertoire, not all the track combinations have the same ratio of victories and defeats. In Table 3 are reported the percentages of defeats calculated for each repertoire based on the various first unfolded music tracks. The differences show that some tracks comparisons may result more difficult to guess than others mainly in the first steps of the game. This is due to the randomness of the track unfolding sequence, which can begin with the comparison of less recognisable tracks, making the whole selection process more difficult.

Table 1: Statistical data for the average duration of the musical excerpts belonging to the same repertoire, of the match and single turn lengths.

	Duration of Song Excerpts (s)	Match Length (s)		Turn Length (s)	
	Mean	Mean	St. Dev.	Mean	St. Dev.
Battisti	33.5	140	43	15	6
Abba	37	138	54	15	7
Vivaldi	40	133	37	14	6
MEAN	36.83	137	45	15	6

Table 2: Number of completed matches for each repertoire with the percentage of defeats.

	Completed Matches	Defeats (%)
Battisti	31	26
Abba	37	38
Vivaldi	31	35.5
TOTAL	99	34.5

[6] www.processing.org
[7] https://cycling74.com/

Table 3: Defeat percentages based on the first unfolded track for each repertoire

	First unfolded music track*							
	1	2	3	4	5	6	7	8
Battisti	0	0	0	33.3%	11.1%	25.5%	50%	75%
Abba	100%	66.6%	50%	75%	50%	42.8%	40%	0%
Vivaldi	33.3%	50%	100%	33.3%	50%	12.5%	25%	25%

* the numbers correspond to the musical tracks depicted in Figure 1

4 CONCLUSION AND FURTHER WORK

The "Good or Bad?" game provides users with the possibility of listening to music in an unusual way. Exploiting the characteristics of multi-track recording, the game allows a deeper understanding of the existing relationships among the various musical functions inside a polyphonic music score. Actually the possibility of navigating through a multi-track recording of a piece corresponds to the ability of playing the single parts of an orchestral score and of discovering all the musical features hidden inside. This opportunity, once allowed only to professionals, is now available for everybody through the engaging and playful approach of "Good or Bad?". While this may be considered a remarkable aspect of the gamification of musical listening, another aspect needs further consideration and reflection. This is the very short time devoted to musical listening (average of 15s per turn corresponding to less of the half of the duration of the musical excerpt). If the authors' aim was to improve the attention to musical features and to increase users' listening skills, this seems to be a contradictory result. On the other hand, also if the evaluation time does not impact on the game's score, the mechanism of the game seems to invite the players to make their choice as soon as they think to have grasped the essential elements of the music, and, actually, also this can be considered as a listening skill. It is probably necessary a negotiation between the advantages and characteristics of the game and the attitude to reflexive listening, considering the latter as a goal to be achieved and not as a common habit. A listening game such as "Good or Bad?", originally designed for entertainment, could easily be included in music education programs with the addition of tools for reflection and awareness such as questions on the musical features, the description of the reasons why a track has been judged similar to another and so on. Moreover students could arrange themselves the musical tracks for the game, thus becoming aware of the elements of the comparison and of the differences/similarities to be discovered.

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