Pyvox 2: an audio game accessible to visually impaired people playable without visual nor verbal instructions

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Abstract. In games, we can discern two approaches to learn how interactivity works: the instructions for use and the interactivity itself. The number of spoken languages is evaluated at more than six thousand eight hundred: for this reason, instructions for use can't make games understandable for all potential users, which is especially true for audio games accessible to visually impaired players, since those games can not count on visual support and have small budgets. Such games don't provide translation, perhaps because of a lack of cost effectiveness. So, if the purpose of a game is to learn in a friendly but challenging way how interactivity can become complex, why not start this process from the very beginning, without the need of textual instructions? Some musical toys have their sighted users accomplish very simple actions in a funny way, without the need of instructions for use. Moreover, video games show us that it is possible to separate the learning process of a complex task in small steps easy to master. We have made a game according to those principles and realized an experiment to test it. All the players managed to progress in the game but not all understood all the principles of the game. For this kind of game, we assume that players do not have to understand the game during the first contact but they have to be encouraged to continue interaction. At last, the increase of the difficulty level has to be very progressive.

Keywords: audio games, accessibility, usability test, interactivity, sound design, interactive music.

1 Introduction: audio games without language for a greater accessibility

1.1 Without visual support, languages are less understandable

Accessibility in games is becoming every year a more important preoccupation in the industry and the report published by the IGDA marked a significant step [1]. The purpose of this study is to understand how visually impaired people can easily master new accessible audio games. Recent research and observation gave a good overview of the existing audio games [2], [3], [4], [5]. Actually, there are more than four hundred games which are accessible to visually impaired players. It is possible to adapt mainstream games into accessible ones as it was done for quake adapted into audioquake [6]. It can be easier to think about the accessibility of a game starting from the beginning of its development. For this to be done, research proposed guidelines for a better accessibility in games [7], [8].
However, these studies do not consider accessibility problems related to language aspects: language is an inaccessibility factor for those who can't master it. Moreover, recourse to translation, which implies increasing development costs, doesn't allow us to target all the potential users: there is too much language, even among the most spoken, to operate all the translations. Now, an important part of existing audio games requires good understanding of the principles of interactivity: for this reason, the comfort given by language is tempting but even for those who master the adequate language, it can be an obstacle to amusement. Most of the actual and popular audio games need a lot of reading before players can start to play them efficiently. For players who don't master english, the game is not accessible. This is why it can be advantageous, for accessibility studies or for economical needs for international distribution, to develop games (followed maybe by other kinds of software) without communication via language.

1.2 Some studies encourage the making of audio games

Are audio games without language realistic? A. Darvishi confirms that an information technology environment using various sonorities provides support for the understanding of the interactive process [9]. But this study doesn't say if sounds alone could be sufficient for correct interaction. For this reason again, the encounter of experimental research on audio games and the field of non linguistic communication could bring interesting results. This can be a way to orientate the purpose of audio games towards a more musical outcome: interactive music. Even without the help of tactile perception, J.L. Alty points out that music is usable as the main means of communication, with three centres of interest: the communication of musical algorithms, debugging, and communication for blind people [10]. Regarding this third area, A. Darvishi uses sound synthesis in a virtual environment accessible to the blind, each sound being the result of a particular configuration of the environment [9]. One of the problems of this approach could be the difficulty to convey precise

information with sound synthesis, because of its very abstract nature, not really suitable for communication. However, there are various ways of arriving at a fuller level of communication. For example, B.N. Walker manages to communicate numerical data via a musical abacus [11]. In addition to scientific studies, other ways of investigation may be very helpful.

2 The influences of multimedia experiments and video games

Audio games are not the only interactive enjoyment. We will now study how interactivity works with musical toys and what is the importance of language in them. They could be a good source of inspiration for working on the first contact between an audio game and its users. Then we will consider video games because some of them present interesting learning processes. Both multimedia experiments and video games could provide clues for the design of audio games without language.

2.1 Influences of multimedia experiments: language is not necessary when simple actions must be done

Interactive artistic audio experiments provide clues for non linguistic communication. These multimedia experiments are often very abstract audiovisually, with no objectives and with no instructions for use. Users have to discover by themselves how to interact with sounds and their misunderstanding can be considered as a part of these artistic works.
Most of them are unfortunately inaccessible for blind people, due to the importance of the visual interface. This is even truer when these experiments show small interactive buttons on a large non interactive visual surface and when there is no musical information about what is under the cursor. In this case, information is given by language but often in a graphical, inaccessible way. This is the case for "Audiomeister", an experimental musical mixer: it is simple, easy and funny to use but only for the sighted people. This first multimedia experiment suggests that immediate funny audio feedback is essential for the users. In "Snapper 8:8", all the visual zones are interactive. It is thus possible for blind users to use the mouse and click randomly on the screen, but it must be on the zone covered by the experiment. For a sighed user, this musical toy doesn't use instructions: users discover by themselves how to produce music, and it works well with sighted users. They realize two kinds of usual gestures: first, they move the mouse, anywhere on the surface of the experiment and then they click, nothing else. They just have to do these two usual gestures. We have presented these experimentations to some blind people; for them, it is harder: they need to know they must move the mouse and click. Moreover, for a blind user, the purpose of the experiment is not evident and they must be informed that it is a multimedia experiment. Other experiments are linked with movements of the mouse, without the need of clicking, for example to give an attractive musical rendering when the cursor meets specific fields. This kind of interactivity can be done without linguistic instructions for use.

The interaction in this type of experiment depends on exploration of zones. The "Spacializer" is a good example of this kind of musical toy. We can hear interactive sound, when the cursor is on specific zones, just by moving the mouse. This kind of experiment is even more easy to use because it needs the user to do not two but only one kind of gesture: to move the mouse.
However, these multimedia experiments present two problems for visually impaired people: the use of the mouse is not a habit, even if more and more audio games are based on this device and without visual perception, the purpose of these experiments is not evident.
Therefore, we suppose, on a strictly hypothetical way, that multimedia experiments using the keyboard may be more easy to use for blind people. Actual audio games use the keyboard. But this is not sufficient: keyboards have many keys and users must know which keys are useful.
Moreover, without the visual representation of the multimedia experiment, blind people can't represent to themselves the purpose of this activity. "are there any objectives?" Or "what am i supposed to do?" Are things some of them said while they tried these experimentations. One particularity of these experiments is that they usually are toys where users don't have to accomplish objectives. Concerning video games or audio games, they are no longer toys but games. We want to make a study on games rather than on multimedia experiments because we want to understand how users can elaborate a complex way of interaction with an application. Multimedia experiments only present simple ways of interaction with interesting audio feedback. There is no particular challenge to beat. Games, through different objectives, manage to complicate the interaction through a learning process. We think that the starting point of the learning process of audio games needs some characteristics of multimedia experiments in order to make a pleasant first contact. We have considered multimedia experiments and we will now consider video games to know more about the learning process.

2.2 Learning process of video games: simple learning processes may be combined for the understanding of a more complex task

Over the last years, video games have been more often analyzed by scientific studies. These new studies allow us to define the nature of games, writing processes, technologies and the cultural impact [12].
It is easier for the player to learn a game with instructions included in the first step of the game. In this way, the player uses less his memory and he can practice without delay the instructions he learnt without risks of forgetting. Moreover, it is only when a lesson is understood by the player that the next instructions are given. A complex task may be divided in a great number of short or funny and easy to understand lessons often called "tutorials". For more complex games, we might fear that the amount of instructions is much greater. This will be more often not true than true. Linguistic communications are sometimes used but not always. The first basic actions are explained with verbal instructions and the player must understand by himself the combination he can make.

The great difference with simpler games is that learning is no longer presented before the game but incorporated in the game itself. Tutorials often have the following characteristics:

- No or very few « game over » situations;
- Players face situations that can only be resolved in one way;
- Clues make the resolution easy. Clues may be audio, visual and / or tactile;
- There are few advantages to the player to go back;
- Players should be very interested in going further.

Approaching each of these characteristics from an auditory rather than a visual point of view may be of great interest. So, there is a paradox. The number of instructions does not depend on the degree of complexity of the game. For complex games, developers are looking for other ways to make players learn and quickly enjoy themselves without being discouraged. Considering, on one hand, that perhaps simple interactions don't need instructions, as suggest to us multimedia experiments, and on the other hand, that the understanding of simple interactivity may be combined, it should be possible to develop audio games without linguistic communication.

2.3 Playing toy-games

For an audio game without language to work, the game should also be a toy. The learning process isn't homogeneous. It depends on each user individually and in order to avoid discouraging them, each action should bring enjoyment. This was one of the objectives of a particular game: the phase project [13].

Phase is a game which can be understood in three different ways: in a visual, an audio or a tactile way. Area exploration and gesture have both been integrated, each of these kinds of interactivity provides musical transformations in the game. For this reason, phase is a toy because each action has an amusing outcome. In the same way of the musical experiment we have considered, players can produce music just by moving a haptic joystick. They can produce other sorts of spatialized sound by exploring zones. Phase is also a game and more exactly a race game where players can catch a musical entity running along the horizon of an audio tactile landscape. The rule of the game is also induced by the musical outcome. The faster the players go, the more the music is exciting and interesting. Because of the constraints arising from the context of an exhibition, this game was voluntarily very simple. Phase was used by people of all nationalities, without having to be given instructions, except in a few cases. A lot of blind people successfully played this game as a toy and some of them succeeded in the game. These are very encouraging results for using this type of design in audio games. We have made a game on similar principles, for a more standard configuration: no more tactile feedbacks, but the use of the keyboard, and the audio feedback in stereo only.

3 Experiment

3.1 General hypothesis

Ideally, a game should be playable as soon as a player has a first contact with it, during the learning phase and without the help of someone else.

3.2 Study environment

During tests of preliminary projects without verbal instruction, we have noticed that it is better if the player chooses himself the adequate moment for interaction. The making of an action game where timing is important seems harder to do.
This is the reason why we have made two maze games. Players have all the time they want to interact without any consideration of timing. The first one, named "Pyvox, musical maze" uses an included verbal tutorial but it was also tested without these instructions. Results were encouraging: in the non-verbal version, the players did not manage to progress as far as in the verbal one, but almost all the players managed to play the game [14]. The second one, named logically "Pyvox 2, more musical mazes" doesn't use verbal instructions. The beginning of this game also works as a musical toy. For both of these projects, we have used usability tests as often as possible since the beginning of the development. During these tests, we don't present any instructions to the player except that "it is a game and for the purpose of the test, it is better if nothing is told about the rules of this game." Then we consider the progression, the keys the player uses and the problems of understanding he (or she) meets. After each test, we include new modifications to the game.
After this iterative process, we obtained a game with the following features: the player directs a character in a seventy floor labyrinthine tower, seventy floors corresponding to seventy game levels which can be explored one after another in an unchanging order. The character can also be considered as a cursor that can be moved on a grid from one square to the other. The player can move the cursor towards target areas but obstacles block up some access paths. This game is a maze with a square-to-square moving system, divided into game levels, each level presenting an exit and a certain number of walls. The aim of the game is to teach the player to recognize an exit sound just by using non-speech audio. The game also aims at making the player recognize the sounds coming out of the walls in order to avoid them without hitting them; this recognition is obtained with similar non-verbal principles: the walls emit sounds in order to make the player feel where the obstacles lie. This principle is conveyed implicitly: we wanted the sounds to be slightly unpleasant so as to force the player to take his character away from the walls. The link between those sounds and the walls is understood rather quickly. More pleasant sounds can then be heard. As a first contact, the game introduces the character sleeping. The keys of the keyboard almost all trigger alarm sounds. The closer the player gets to the arrow keys, the louder the alarm sounds become. The use of the arrow keys wakes the character up and the exploration of the maze can start.

3.3 Aim of the study

We want to optimize the handling of audio games by tackling the problems linked to language. We also want the visually impaired player to be able to learn the rules of the games without verbal instruction.

3.4 Studied population

The testers selected for the experiment are two groups of teenagers who have participated in the international computer camp 2007 (ICC) in the Arla institute from Espoo, Finland. They are all visually impaired. During the first week of the ICC, the teenagers were between fourteen and seventeen years old. During the second week, the first group left and older teenagers aged eighteen to twenty two came instead. The experiment was realized during specific workshops about audio games, so the testers had very little time - about three hours - to try more than a dozen games. Some of the testers wanted to put an end to the tested game in order to try the other ones before the end of the workshop. The other presented games were: “Terraformers”, “Shade of Doom”, “Sonic Zoom”, “Sarah in the Castle of Witchcraft and Wizardry”, “Super Egg Hunt”, “Mudsplat”, “Super Liam”, “Pyvox Musical Maze”, “Tampokme”, “Chrono Mouse”, “Descent into Madness” and “Top Speed 2”. However, all these games were not always presented at the same time due to computer reconfiguration. Due to the conditions of the workshop, it was not possible to make a preliminary study to know for example if each tester was familiarized with audio games. The players were here to discover audio games and they had very little time; also, during the tests, we had to help players who were trying other games. Unlike with Pyvox 2, we had to explain the rules of those other audio games since they were not meant to be played without prior knowledge of instructions in the manual.

3.5 Variable independent from the user

We counted the duration of each game and the highest level reached.

3.6 Variable dependent from the user

We tested a unique version of our game, but we consider separately the two groups of testers, with different ages:
C1: testers from the first week of the ICC07, between fourteen and seventeen years old.
Unfortunately, we only managed to gather seven testers during the first week. Workshops did not occur all the days, and the first attempts were lost due to the preparation of the audio games for the ICC.
C2: testers from the second week of the ICC07, between eighteen and twenty two years old.
We managed to collect sixteen testers during this second week.

3.7 Instructions

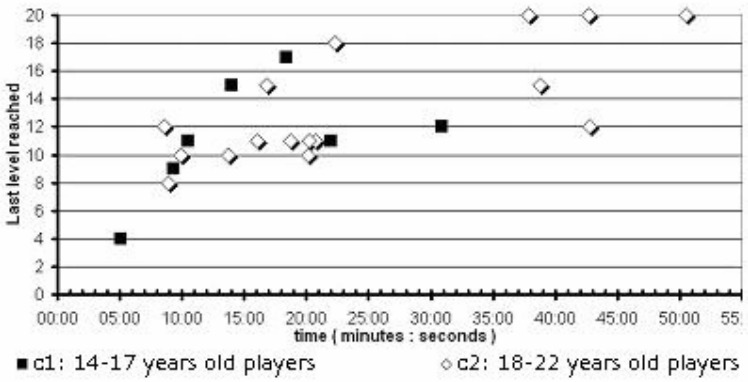
In this study, the testers are not faced with the device freely, they are aware of the following details: they are going to try a game, the purpose of which is not given. They can play as much as they want. They can give up the game whenever they want to but they cannot resume it. They can adjust the sound volume with the controls indicated by the experimenter. The controls to adjust the sound volume are tested by the players. The experimenter starts the game and leaves the players to use the device until they want to stop the game by themselves.
Each tester only does a single game without preliminary training.

3.8 Operational Hypothesis

We assume that our game without language but including the learning principles previously suggested could be understood and properly played by players from the two age groups. However, we have noticed from previous tests that there could be very different reactions between players, depending on their ages. Adults without game experience for example may have great difficulty to handle audio games and to understand them. For this reason, we want to compare these two groups, without manipulating any other variables in order to have a better understanding of the different kinds of reactions to a same material.

4 Results

Table 1. Main results of the two groups of players.



All the testers managed to pass the three first levels. Six testers ended the game at the sixth level. The majority of the testers, sixteen players out of twenty three, have played the game between eight and twenty four minutes. Six players have played more than thirty minutes. The five more persevering players are from the older group

and the most persevering has played fifty minutes. The four players who have reached the highest levels are all from the older group too.

5 Discussion

All the testers managed to pass the three first levels (Fig 1). However, it doesn't mean that all the testers understand the principles of the game. At this point, the majority of the testers did not represent to themselves the game as a maze game. We have noticed during the ICC, that some sighted staff members failed to pass this third level, staying on the left of this audio maze without being able to go to the right side. For this reason, we consider that the level design of the first level should be improved with a lower difficulty level.

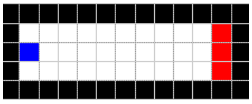


Fig. 1. The third level of Pyvox 3. The starting point is on the left and exits are on the right.

The increase of the difficulty level seems particularly problematic for the level number eleven (Fig 2.). Six testers ended the game on this level. Six others did not manage to reach this level and ended the game before. Eleven testers managed to pass this level.

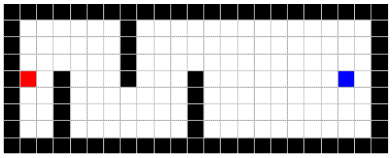


Fig. 2. Level eleven of Pyvox 2. The starting point is on the left and the exit is on the right. The player has to recognize and avoid three walls on the path before he can find the exit.

We think that the testers who managed to pass the level number eleven have understood the main principles of the maze game: players have to find an exit and the exit is indicated by a specific audio rendering using stereo and pitch variation depending on the position of the player's character compared to the position of the exit. However, at this point, we are not sure whether the players know how to identify walls without hitting them and recognizing the related sounds on impact. The maze is still relatively simple.

We have six testers who have played more than half an hour. The five more perseverant testers are from the older group of testers. The four better players who have reached the higher levels are also from the older group.

Three testers of the older group managed to pass the level number eighteen (Fig. 3). For these players, all the rules of the game seem to have been well understood.

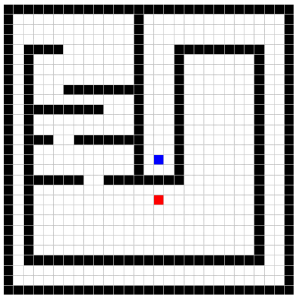


Fig. 3. Level eighteen of Pyvox 2. The starting point is in the center. The exit is near below. The player's character has to take the path on the right and go round the maze.

Despite these observations, there does not seem to be strong difference between the two groups.
We assume that not all the players understood all the rules of the game, but these results are related to their first attempt, without any preliminary training. Other attempts from the players should allow them to progress further in the game.
We consider that the players do not have to understand the game but have to experience enjoyment during the progression. What is important in games is the feeling of enjoyment. This particular sensation in games has been well studied since the works of Csikszentmihalyi about the flow theory [15]: a game is good enough if it strikes a balance between the challenge proposed by the game and the player's abilities. The flow zone, which is the feeling produced by good games, is in the middle of two opposite sensations: anxiety and boredom. It is not directly linked with the concept of understanding. Jenova has worked on the flow theory and used it to give us a very interesting game named "flow", without any verbal explanation [16]. Pyvox 2 is a game, and we consider that the difficulty to understand the principles of the game can be a part of the proposed challenge. However, the learning process could be facilitated and reviewing the level design and the sound design should help to do so.

6 Conclusion

We have envisaged that multimedia experiments allow the players to play with music as if they were playing with a toy: there is no objective. Then, we have seen that there are many ways to interact with these toys: by clicking or just by moving the mouse. Some of these experiments don't need instructions for use for sighted players who understand by themselves how to play. There are no multimedia experiments which are specifically adapted for blind people, we suppose that three factors are important for a good use of these multimedia experiments: usual gestures, funny and immediate

audio feedback and finally, a good representation of the purpose of the multimedia experiment. In the next part, we have considered video games and their learning process: a complex task may be divided in many simple lessons that are easy to master, all included as a first part of the game. The first contact between players and audio games without language or other accessible audio software should combine the qualities of toys and games. Toys are fun to manipulate without instructions. Games encourage progression in the manipulation by a pleasant learning process. An audio game without language could imply that first, the player discovers a toy and then, because the audio rewards are not all the same for all the interactions, he is looking for the manipulations which provide the best encouragements. So the sound toy should successfully become an audio game without language. The making of an audio game without language implies that we can't develop a specific type of game without making other games for prerequisite knowledge: how to use the keyboard, which keys are really useful and which keys are not, what are the consequences of their usage. This is a whole chain of minigames that should be linked up in order to understand and play the desired game.

We have tried to implement those principles in a maze game. We are satisfied with the results, considering that they concern the first attempt without any preliminary training and without any explanation. However, we think that the learning process can be facilitated by making a level design with a more progressive increase of the difficulty and by improving the sound design again.

We are currently working on a third audio game named "Pyvox 3", it is also a maze game without verbal instruction and with a multiplayer feature. Thus, we think it can be easier for players to communicate hypotheses about the rules of the games.

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