Audiogames: Accessibility and Inclusion in Digital Entertainment

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Abstract. Video games represent one of the most popular forms of digital entertainment, but people who are blind or visually impaired end up having restricted access to these games. Discussions about digital accessibility and inclusion often end up leaving this question aside, in favor of some discourse considered more "utilitarian" or "productivist". However, video games have a relevant role in contemporary culture and can bring cognitive, motivational, emotional, and social benefits, as well as contribute to the well-being of their players. Audiogames are a specific type of digital game that have sound and sometimes tactile stimuli as their central element, rather than visual graphics. Thus, audiogames can create atmosphere, mechanics, and unique gameplay, while making digital entertainment more accessible to people with all levels of vision. It is also necessary to consider (and charge) the need for other types of digital games to comply with accessibility guidelines and to guarantee the right to play for everyone. Digital games that promote universal design and that are capable of captivating their players can ensure that people with different levels of vision can interact, collaborate, and even compete on equal terms with the same game - a situation that can not always be observed in other everyday situations.

Keywords: Videogames · Audiogames · Accessibility · Digital inclusion
Well being

1 Introduction

It is estimated that there are 250 million blind or visually impaired people (BVIP), about 3.3% of the world's population [1]. When talking about digital inclusion and accessibility for this group, one usually thinks of ways of accessing information, education, or work [2]. Approaches that prioritize forms of leisure and entertainment are often cast aside in this discussion for a more "utilitarian" or "productivist" discourse.

This text, therefore, starts from the premise that the issue of digital inclusion and accessibility and welfare for BVIP must - within the contemporary context - also consider the digital forms of leisure and entertainment. Video games have become the primary entertainment industry, moving a market of $116 billion in 2017 [3] with an estimated audience of 2.21 billion active players - about a third of the planet's population [4].

In addition to its economic relevance, authors such as Huizinga [5] and Callois [6] emphasize the importance of playfulness for the constitution of the social subject. In the

particular dimension, playing contributes to the processes of structure and well-being of the individual. Collectively, playfulness inserts people into cultural dynamics that ultimately shape their perceptual judgments and the very society in which we live.

We must also consider that video games are the gateway to digital culture. Children traditionally learn to play video games before using a computer just as they learn to draw before writing [7]. Likewise, the use of video games makes the digital literacy process more comfortable and faster [8]. This fact may be particularly relevant for BVIP since they often have to overcome additional barriers in these processes due to the technical and technological limitations of digital equipment and contents - which do not always meet the norms and demands of accessibility [2].

Video games also represent an essential form of socialization in the contemporary world. MMOs (Massive Multiplayer Online games), for example, require the creation of groups of players from established relationships within or outside the game universe. In the same way, other types of games stimulate the creation of communities, even if not necessarily to play. Such is true in the case of production of complementary content, sharing of tips, comments, and other experiences and collective constructions [9].

Furthermore, several studies indicate that video game can enhance well-being and have cognitive, motivational, emotional, and social benefits, even in the case of games not explicitly designed for such purposes [10].

Audiogames is the term that has been used to define video games that contemplate this demand for BVIP. In the sequence, we will present some definitions and questions related to the audiogames, followed by a survey on the state of the art of research in this field. In the end, we present the results and discussions obtained from the study carried out, with the primary objective of corroborating the inclusion and digital accessibility, the right to digital entertainment, and the welfare of this public.

2   Audiogames: Trajectory, Typology, and Characteristics

According to this research, an audiogame is a type of digital game that has sound as its central element, that is, as its chief mechanics, interfaces, output and feedback. Sometimes, these games may contain also tactile stimuli rather than visual graphics. Thus, audiogames can create atmospheres, mechanics, and unique games while making digital entertainment more accessible to people with all levels of vision.

At the beginning of the commercialization of digital games, BVIP that had access to a computer paradoxically found fewer accessibility problems and fewer difficulties to play some of the regular commercial games. Interactive fiction, RPG (Role Playing Games), and adventure games had more elaborate narrative plots such as "Colossal Cave Adventures" (1977) and "Zork" (1977). As the digital resources of sounds and images were insufficient at this time, the use of written language better accommodated such narrative demands. The same was true for the first MMOs known as MUD (Multi-User Dungeon, Multi-User Dimension or Multi-User Domain), for example, "MUD1" (1978). These games, based on written text, were part of a type of digital game known as "text-based games". Although not designed to meet the BVIP, such games could (and

still can) be played by using assistive technologies such as screen reader and speech recognition software and devices [11].

Over time, as the hardware capacity grew, the use of the written text gave way to graphic images and audiovisual language. At the same time, mainstream games (aka "AAA" or "triple-a") have significantly increased the complexity of their gameplay, their interfaces, and their controls, making it even more challenging to access BVIP [11]. On the other hand, the technological advance also favored that new solutions arose for inclusive games.

"Touch Me" (1974) was one of the first games whose technology allowed the inclusion of BVIP [12]. The game consisted in reproducing, in the same order executed by the device, a random sequence that was generated from four sound tones. The objective of the game was to memorize and reproduce the largest possible sequence of sounds. Although each color (red, green, blue, and yellow) related itself to a specific sound tone, the visual element was not essential for its gameplay. In 1978, Atari released a portable version of the game, "Touch Me Handheld Version." BVIP can now use mobile devices to play collections of accessible games, such as Audio GameHub [13]. Despite the distance of forty years, the mechanisms responsible for running these games still have some ergonomic and design similarities (Fig. 1).

Fig. 1. On the left, image of the portable device "Touch Me," released in 1978. The right, smartphone running "Audio Game Hub," [13] released in 2016. (Source: author)

Games like "Touch Me" or even text-based games, although not specifically designed to be accessible, allowed BVIP to play and also to compete and interact with any player, including sighted people. This fact is particularly relevant if we consider that BVIP regularly lives in their personal and professional relationship circles with sighted people, who are also, sometimes, video game players.

Archambault et al. [14] identify three distinct types of audiogames: those that predominantly use audio, although associated with a visual interface, those linked to experiments of musical artists, and those that use "only" sound elements to play.

The "Game Accessibility Project" understands that games accessible to BVIP can be classified as text-based games, mainstream video games, audiogames, video games accessible by their original design, and mods-accessible video games (MODs) [11].

Regarding text-based games, in addition to what has been commented previously, although there are several examples of this type of product, they have become less popular these days. It might occur because they do not offer the same diversities or other attractive resources if compared to the most wanted games by the players.

In mainstream games, it is worth pointing out that some BVIP develop considerable skills in games that had been designed, initially, for sighted people, becoming "hardcore gamers". One of the cases that gained media notoriety was that of blind player, Brice Mellen, who was considered a major competitor in the "Mortal Kombat" fighting game.

"Skullgirls" (2012) is an example of a fighting game that had not been originally developed to be accessible but is played by BVIP, mainly because of its feedback and its specific use of sound language. From the detected demand, the developer studio, Reverge Labs, provided customizations that favored the gameplay by BVIP. As a result, "Skullgirls" is often referred to in specialized forums as one of the most accessible mainstream games and one of the favorites among the blind and visually-impaired players [15].

Audiogames are understood by "The Game Accessibility Project" as games that use "only" sounds and are without any visual output. Although they can be played by sighted people, they are, very often, more attractive for BVIP. Therefore, they end up being developed by enthusiasts, by academic projects, or by the blind community itself. "Most audio games are elementary games (compared to conventional games) and lack many of the properties of conventional games, such as diversity, multiplayer functionality and good replayability" [11]. One exception is the popular "TopSpeed" car racing series, an audiogame that features three sequences developed by Playing in the Dark Studio.

Even when sound-based audiogames reach a broader audience, they continue to be received peculiarly by BVIP. As an example of this statement, we can cite the horror audio games, such as "Papa Sangre" (2010). In these types of games, the emphasis is much more on the absence of a sense, the vision, than on the empowerment of hearing [16].

Regarding the category of video games originally designed to be accessible, perhaps this is the one that best represents the proposal to develop an inclusive (and not exclusive) project. "The Blind Eye" (2010) was a pioneering effort that aimed to explore the potential of developing a 3D game for BVIP focused on the development of skills related to navigation and spatial cognition. Like "The Curb Game" (2005) and "Terraformers" (2003), the game is also considered "hybrid," which means that it has visual graphic representation. This pioneering work has led to the exploration of technologies unheard of at the time, such as an interactive binaural sound. The focus on auditory navigation was the exploration of binaural (3D sound) sound environments. In the game, the avatar controlled by the player must locate a series of musical instruments that are placed in different places of a city - each with a characteristic sound landscape. The instrument starts playing when the avatar approaches. When locating all the instruments, the player has to find a garage where a man is playing a kind of barrel organ. There is a time limit of 60 min to complete the game, and collisions with cars and walls are obstacles that draw energy from the avatar. Directional buttons give control to the player, while the step sounds function as a location reference; if they can be heard more clearly, the avatar is close to a wall; if they

are not so clear, it is because the avatar is walking in an open area. Although in some moments the game uses voice over narration, it is a good example of a more expressive exploration of sound design in video games and the potential of audiogames.

Modifications in games, also known as "MODs," are changes made by players and enthusiasts who bring some modification to the original game - be it more superficial or structural [17]. Thus, some modifications are made with the aim of adding accessible features, enabling BVIP to play such modified games. An example is "Accessible Quake," also known as "AudioQuake" (2007), an accessible version of the popular First Person Shooter (FPS) "Quake".

The portal "Audiogames.net", one of the primary references on this subject on the Internet, classifies this sort of accessible games in a way that resembles the ordinary video games' genres. These categories are action games, adult games XXX, adventure games, audio adventures, arcade games, card games, first-person adventures, FPS, gamebooks, incremental games, interaction fiction, interactive fiction interpreter, Japanese games, MUD, MUD clients, MMORPG, puzzle games, racing games, role-playing games; educational games, side-scrollers, space invaders games, strategy games, trivia games, traditional games, sports, simulation games, word games, compilations, and miscellaneous [15].

This same portal has a very active forum [18] and a repository of audiogames [19] in which it is possible to have access to about 650 titles classified among the 30 categories listed in the previous paragraph. The site comments that it includes only a few interactive fictions because there is already a specific (and more complete) site about this genre called "The Interaction Fiction Archive" [20]. In the repository, it is also possible to check audiogames' descriptions, comments, and records, as well as an updated list of projects under development and credits of 75 developers.

As we look more closely at this list of developers, we can see that they are small teams - sometimes made up of a single person - consisting, predominantly, of enthusiasts, independent studios ("indies") or members of projects that are carried out by universities or sector organizations.

The "Audio Game Hub" is an example of a project that is the result of an international cooperation between the Gamification Lab of the Leuphana University of Lüneburg and the University of Technology's School of Computer and Mathematical Science at Auckland University of Technology. The team was composed of thirteen people, who held the roles of the project leader (Jarek Beksa), design, programming, sound effects, graphics and website; three testers and six voice actors are also credited. This number can be considered quite small, considering the size of video game development teams, the fact that they belong to two different institutions, and the number of games implemented. In total, there are, available for free download, twelve audiogames: casino games, bomb disarmer, Super Simon, archery, hunt, samurai tournament, samurai dojo, labyrinth, memory, blocks, animal escape, and runner [13]. The project, supported by "The Able Gamers Charity" [21], had more than 80.000 downloads with a good average rating (4.8/5.0) and has won important awards, such as "The Play by Play Festival" and the "Royal National Institute of Blind People".

3   Audiogames: State of the Art

This study, to overlook state-of-the-art audiogames, examined books and databases like Scopus, SpringerLink, Mendeley, Scielo, Project MUSE, Web of Science, Google Scholar, and the Academia.edu platform.

Although it is possible to locate the first experiences related to audio games in the 1970s, it was only at the turn of this century that this theme's first theoretical references appeared [22, 23]. Between 1999 and 2016, sixty-five articles were identified that directly addressed audiogame - average of less than four (3.6) texts per year. The Graph 1 below shows this output categorized per year and by type of approach. The first one is theoretical, with thirty-nine papers, which presents theories, concepts, and eventual analyses of audiogames and their benefits. The second one has twenty-six texts about development, which predominantly reveals project documentation and the audiogame implementation process, eventually reporting results from user (player) testing.
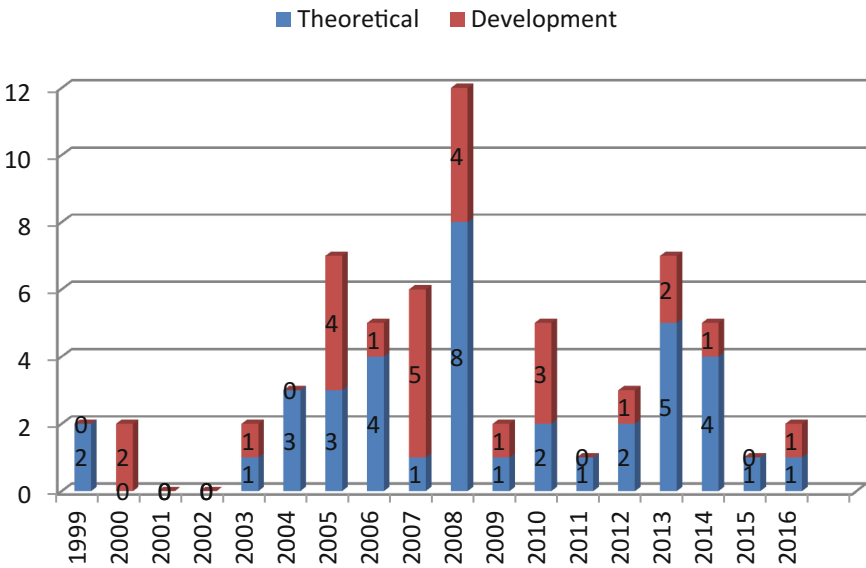
Graph 1.   Division by type of approach and year of publication of articles on audiogames. Seven of the eighteen years surveyed were above average (3.6) of texts produced per year, while two years (2001 and 2002) had no publication. (Source: author)

Another issue raised concerns the country of origin of these publications. The sixty-five texts were published by authors linked to teaching and research institutions in thirteen different countries - an average of five texts per country. Only four countries produced above this average: the United States, Brazil, France, and Austria. We note that, compared with data for the thirteen most significant gaming-consuming countries in the world - which, together, represent 84% of the global market [3] - about half of them are in the two lists (China, United States, Germany, United Kingdom, France, Canada, and Brazil). Also, it is possible to repair a non-alignment between percentage

and position of these countries in the respective rankings, as we can see in the comparison below (Graph 2 and Table 1).
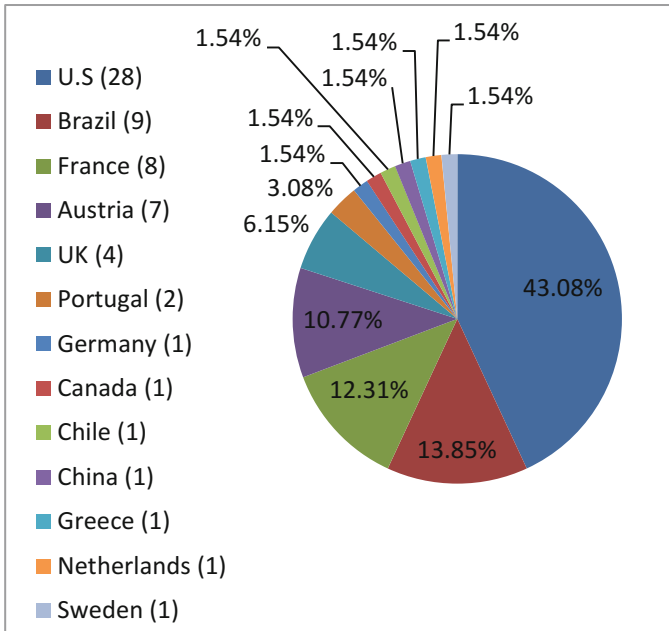

Graph 2. Division of text production on audiogames by country. (Source: author)

Table 1. Largest gaming consumer markets in the world [3]. When comparing the data of the graph with those of the table, it is possible to observe the mismatch between the percentage, the position, and even the absence of some countries between the two rankings.

Country	U$ M
China (28,05%)	32,536
US (21,92%)	25,426
Japan (12,11%)	14,048
Germany (3,82%)	4,430
UK (3,65%)	4,238
South Korea (3,62%)	4,203
France (2,57%)	2,977
Canada (1,70%)	1,968
Spain (1,65%)	1,918
Italy (1,62%)	1,881
Russia (1,32%)	1,531
Mexico (1,22%)	1,418
Brazil (1,14%)	1,324

The survey also identified the keywords associated with the authors themselves and their articles. The five most cited keywords were accessibility (33 times), video games (24 times), audiogames (20 times), visual impairment (16 times), and blindness (15 times). At the other end, among the less cited keywords, one observes the diversity and the high number of terms that were mentioned twice (14 different names) and only once (59 different words) among all the articles surveyed as shown in Graph 3.
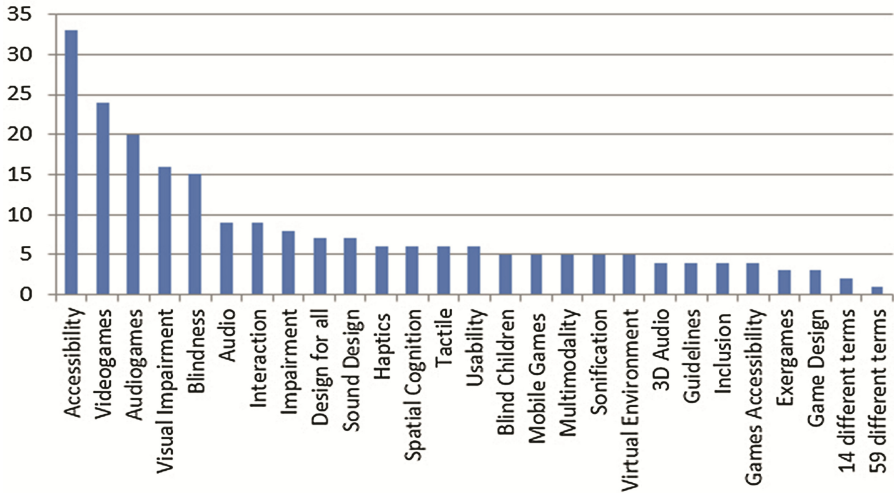
Graph 3. Descending order of the most present terms in the relations of the keywords indicated by the authors in their respective articles. (Source: author)

Other terms that appear most often are audio and interaction (nine times each); impairment (eight times); design for all and sound design (seven times each); haptic, spatial cognition, tactile, and usability (six times each); blind children, mobile games, multimodality, sonification, and virtual environment (five times each); 3D audio, guidelines, inclusion, and accessible games (four times each); exergames and game design (three times each). To better visualize this data, we present a cloud of words (Fig. 2) representing the recurrence of these terms.

Of the sixty-five texts surveyed, twenty-one (about one-third of the total) presented information on the development of one or more skills. In total, twenty-eight mentions correspond to a total of eight distinct abilities. Audiogame players showed improvements in spatial cognition skills (ten occurrences); navigation (nine events); memory (three appearances); physical conditioning (two occurrences); and tactile perception, sound perception, academic knowledge, and Braille knowledge (one incident each).

Fig. 2. Cloud of words representing the terms mentioned in the keywords by the authors themselves in the respective texts. (Source: author)

In this way, it is possible to infer that a little more than two-thirds of the skills are related to spatial cognition and navigation. However, it was not possible to determine if this predominance was due to the identification of a direct demand of the users or for other reasons inherent to the respective projects [22–42] (Graph 4).

Graph 4.   Percentage and number of mentions of skills developed. (Source: author)

4   Results and Discussions

The issue of digital inclusion and accessibility, well-being, and even the development of skills for BVIP should consider audiogames as a relevant form of digital leisure and entertainment. As seen, audiogames can serve as a gateway to digital culture, thus, favoring forms of inclusion, socialization, and digital literacy for this audience [7, 8]. From the design perspective, game designers and other audiogame developers should pay attention to the points and possibilities that we highlight below.

(a) The participation of BVIP as specialists, testers, and team members during all stages of project development must be considered. Thus, it is possible to understand better the profile of this audience, their demands, and preferences rather than to establish assumptions or preconceptions;

(b) It is essential to know the highest quantity and diversity of audiogames, including projects with better and worse acceptance by the public. In both cases, identifying possible reasons for such receptions may provide relevant inputs for the development of new games;

(c) It is necessary to take into account the limitations or technological restrictions of the domestic user (player). In the case of BVIP, there are often additional costs for the acquisition of assistive interfaces, such as adapted keyboards and mice, Braille display and printer, pressure trigger, and tabletop scanner, among others. Thus, it is not possible to assume that the final public will have state-of-the-art equipment such as high-performance sound cards or 7.1 surround headphones;

(d) In potentiating the field of sound design, which is often limited to the soundtrack and sound of images or environments, the sound project and its implementation pass to play a central role in the project. The game is thought from sound, not the contrary. It is, therefore, a form of empowerment of hearing [16] and not suppression of vision;

(e) This is a fertile field for experimentation. Projects that prioritize the sound dimension can also be thought of as works of art and technology or experimental games, as pointed out by Archambault et al. [14]. An example is the project "PHASE – Haptic Sound Application Platform for Musical Awakening (in French)" exposed in the museum Georges Pompidou [43]. In this way, it is possible to expand digital inclusion and accessibility to the field of the arts through playful and interactive projects;

(f) Experimentation also often plays the role of the precursor of innovations that will later be incorporated by the gaming industry. New technological developments, sound language, and sound design can be assimilated into the universe of digital games in general. Cases such as the "Blind Eye" project, which utilizes interactive binaural sound like a game mechanic, favor a more creative exploration of sound as a game design element, not as a mere aid in the sonorization of graphic images in digital games;

(g) Projects with state-of-the-art equipment and technologies not accessible to the home user (player) can be developed for controlled environments such as laboratories, institutions, or schools focused on BVIP. Such projects, although not available to a broader audience, can be used to develop ideas and prototypes that may eventually be incorporated into other situations;

(h) Inclusive games are better than "exclusive games," but more difficult to develop. We understand that one of the main design challenges is the creation of games that can not only be played by BVIP, but also expand their niche and attract sighted players. Universal games favor ways of integrating BVIP not only with other BVIP but also with sighted players - who are part of their everyday relationship circles. From the design point of view, the challenge of the game design is in the development of a game that is not only accessible to both audiences; an inclusive game should also, ideally, be equally attractive, fun, and challenging (motivational) for both audiences. It should favor the flow, the balance and the fairness of the game, allowing BVIP and sighted people to interact, collaborate and compete on equal terms within the game - a situation that can not always be observed in other everyday situations. Cases, such as "Skullgirls" seen earlier, validate this hypothesis and make the possibility of developing such games more economically viable (or attractive) for mainstream developers;

(i) The guidelines for accessibility in the development of digital games should be considered. The "Game Accessibility Guidelines" site presents the results of collaborative work in progress between studios, researchers, and players to establish referrals, with the goal of making games accessible to as many people as possible. These guidelines are divided into three categories: basic, intermediate, and advanced. The levels of this categorization are based on balancing three factors: reach (number of people who benefit), impact (the difference made to those people), and value (cost to implement). It is also recommended to follow a six-step process: familiarize, evaluate & plan, prioritize and schedule, inform, and review & learn [43].

Another site that provides accessibility guidelines is "Blind Computer Games" which provides over fifty items to be checked, classified into six main categories: absolutely critical features, general feature checklist, screen reader feature checklist, self-voicing feature checklist, suggested feature checklist, and subtle factors [44].

Cheiran presents in his master thesis a more comprehensive compilation of several other guidelines, in addition to promoting a comparative study among his recommendations. The research concludes that the vast majority of the instructions studied are applied in a limited way or even not observed in most commercial video games. This conclusion is also corroborated by many of the authors consulted in this research. Cheiran points out that in addition to social responsibility, considering accessibility guidelines is also a strategic way to achieve, from the same game, a new niche of consumers disregarded in the digital gaming market [45];

(j) In the same way that game design is composed of many design elements such as level design, character design, and sound design it is necessary to consider the establishment of an "audiogame design." This new specialty should deepen the discussions presented briefly in this article, to consolidate as a new discipline within the field of digital games;

(k) Develop teaching-learning methods that include BVIP in game design courses, as it already happens in other fields of design, such as fashion, for example [46]. This way, it can allow the access and the inclusion of this public and the formation of game designers who are blind and visually impaired. Such a professional would

develop unique expertise that would transcend both the performance of a game designer and the participation of BVIP as an enthusiastic developer or tester.

5   Conclusion

The issue of digital accessibility and inclusion for blind or visually impaired people (BVIP) is usually thought from perspectives considered "utilitarian" or "productive". Such a discourse often leaves aside the question of digital entertainment - equally relevant in contemporary times. Also, digital games promote and favor the well-being of players, as well as can bring different benefits [10].

Access to these games can represent a significant challenge for BVIP, since, despite the existence of accessibility guidelines, there are still few cases of mainstream games that seek to follow them [43–45]. Despite proper qualification and the market's small interest in applying these guidelines, audiogames have been gradually gaining more space in recent years. This can be perceived through the mapping of the research done, the games developed and the community engagement in various projects and actions [11, 13, 15, 18–21, 45–47].

In this sense, audiogames are offered as an alternative for the inclusion of players in the universe of digital entertainment. However, this type of video game is, in most cases, being developed by enthusiasts or small groups with training and resources more restricted when compared to the mainstream games. Thus, although developed voluntarily and well received by BVIP, many audiogames end up being limited to this group of players.

Considering that BVIP regularly cohabit with sighted persons, inclusive digital games should not be "exclusive." This is true not only for poorly accessible mainstream games but also for audiogames that do not have the same attractiveness of other games for sighted players [11]. Thus, we believe that as important as promoting the accessibility of mainstream games is the development of audiogames capable of including both BVIP and sighted people who regularly play other games.

By meeting the accessibility guidelines, indies and mainstream games can reach an expanded audience and a new niche market formed by BVIP excluded from this type of production. In the same way, when thinking about audiogames capable of captivating sighted players, it is possible to reach a wider audience, which can make feasible the investment of more resources in the development of this type of digital game. In both cases, the search for a universal game design should seek to satisfy the points and possibilities highlighted in the previous section of this paper. These points and possibilities were derived from the literature review and suggest avenues for promising developments in this field.

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