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Playing Blind: Revealing the World of Gamers with Visual Impairment

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ABSTRACT

Previous research on games for people with visual impairment (PVI) has focused on co-designing or evaluating specific games - mostly under controlled conditions. In this research, we follow a game-agnostic, "in-the-wild" approach, investigating the habits, opinions and concerns of PVI regarding digital games. To explore these issues, we conducted an online survey and follow-up interviews with gamers with VI (GVI). Dominant themes from our analysis include the particular appeal of digital games to GVI, the importance of social trajectories and histories of gameplay, the need to balance complexity and accessibility in both games targeted to PVI and mainstream games, opinions about the state of the gaming industry, and accessibility concerns around new and emerging technologies such as VR and AR. Our study gives voice to an underrepresented group in the gaming community. Understanding the practices, experiences and motivations of GVI provides a valuable foundation for informing development of more inclusive games.

CCS CONCEPTS

• **Social and professional topics** → **People with disabilities**; • **Applied computing** → *Computer games*;

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1 INTRODUCTION

When designing technology for people with visual impairment (PVI), there has been a strong focus on the design of tools for navigation and wayfinding [2, 44, 60, 63, 76, 82, 85], for mobility training [122], and tools for creating, communicating and rendering graphical information [3, 17, 75], with less attention being placed on leisure activities such as creating art [52], travel [104], dating [65], participating in sport or physical activity [31, 56, 73], making music [30], and playing games.

Games in general, and digital games in particular, rely heavily on visual stimuli to present information to players. Indeed, digital games are commonly referred to as videogames, a name which emphasises their visual, "video" content. This reliance on visual information excludes PVI, as games demand sensory capabilities that exceed those of PVI [29, 118]. With digital games becoming an ubiquitous cultural phenomenon [20, 42], exclusion of PVI needs to be addressed.

Many digital games have been designed to address exclusion of PVI. Some may include a graphical interface, and can therefore be categorised as videogames. Some games have focused on assisting PVI to navigate physical locations by reproducing these locations in a virtual environment, obtaining improved orientation and mobility outcomes [32, 94, 95]. Others have focused on the use of videogames for educational purposes, designing interesting interaction mechanisms such as compass, radar, and musical metaphors [66, 103]. Others

have argued for the need of equitably accessible games, and designed videogames for PVI for hedonic purposes [100].

Apart from research-driven initiatives, gamers with visual impairment (GVI) have responded to the challenge of interacting with visually rich videogames by engaging with Multi-User Dungeons (MUDs), audiogames, and mainstream games to an extent. MUDs are text-based adventures and its origin dates back to the 70s [12]. By being text-based, MUDs are accessible to existing accessibility software. Audiogames are a type of digital game that includes an entirely auditory interface and may or may not include a graphical interface [45, 66]. The engagement of GVI with mainstream games depends on their remaining sensory capabilities.

Unlike previous studies, we have not designed a game especially for PVI. Rather, we present findings from a study that investigated the current experiences and preferences of GVI. We have followed a game-agnostic, "in the wild" approach that privileges the views of GVI. In doing so, we aim to understand the habits, opinions and concerns of GVI in regard to videogames. By giving voice to this under-represented group in the videogames literature, we seek to move towards an approach that empowers PVI and encourage their engagement with fun and inclusive gaming experiences [91].

2 RELATED LITERATURE

This study is concerned primarily with the habits and practices of GVI. Our work is informed by literature that considers broader issues of VI as well as by our understanding of games and more specifically, of audiogames and of other assistive technologies that have been deployed for PVI¹ both within and outside game settings. It reflects our belief that research into VI should focus not only on the instrumental supports and aids that PVI require but also on the "beauty" and the "wonder" of play purely for play's sake [122].

HCI and people with visual impairment

There is a significant body of research that considers the specific difficulties experienced by PVI in using social media and crowdsourcing tools [105, 106] as well as issues related to employment and participation. PVI experience higher rates of unemployment and of underemployment than are found in the general population [53, 83, 107]. To date, much of this research has been focused on everyday participation, including key workplace issues such as accessibility and the education of sighted colleagues [109]. Dobransky and Hargittai [36] have explored internet adoption by people with disabilities in the US and argue that technology has a tremendous potential to include these individuals in an inaccessible

society. With the focus of accessibility research on workplace accessibility, PVI may feel excluded from creative and leisure activities [118].

There has been little work done in HCI to explore VI players' own practices and experience, although there are isolated examples of participatory design work with VI participants in HCI [52] as well as other work which examines workplace practices [21]. Harris [57] suggests that while people with disabilities are initially excited by new technology, many devices end up unused and forgotten. Similarly, Macdonald and Clayton [74], and Moser [79] argue that digital technologies seem to construct new disabling barriers. Rather than proposing new technologies, our research examines how PVI choose to engage with games as a leisure activity, and what accommodations they use and require.

Games for PVI

There is a growing body of research into making gaming accessible for PVI [6–8, 14, 59, 108, 112, 118], allowing them to "experience some of the more advanced types of computer game technology and enjoyment that sighted gamers have taken for granted for many years" [10]. Like research into real-world navigation tools, responses to this have considered the accessibility of virtual environments [69, 113] as well as wayfinding [19] and sensory substitution [11, 77]. For example, some games have focused on assisting PVI to navigate physical locations by reproducing these locations in a virtual environment, obtaining improved orientation and mobility outcomes [34, 94, 95]. Some videogames have been designed for use in formal educational settings, utilising interesting interaction mechanisms which have been replicated in audiogames, such as compass, radar, and musical metaphors [66, 103]. Other researchers have argued for the need for equitably accessible games, and designed videogames for PVI for hedonic purposes [100].

Games specifically designed for players with VI include memory games [88], action games including first-person shooters [54, 66], platformers and racing games [66], boardgames [55], exergames [89], games with tactile interfaces [97], music games [66] including *Blind Hero* [117], interactive text-based games and MUDs [66], directional games [66], and games based on exploring 3D virtual worlds [47, 103], including *Terraformers* [111], *Swamp* [64], *Shades of Doom* [46, 115], and others. Games are also used instrumentally, for example to improve accessibility of the World Wide Web [108], as teaching aids [66, 93, 120], or to specifically address issues of game level creation [10].

Common to this research –which may include participatory designs with VI players– is a focus on what studios or designers can do to improve the experience of gaming with a VI; a primarily deficit-driven approach. Accessibility is *designed into games* and is *presented* to VI players. It has been

¹Although we consider it to be insensitive to use an acronym to refer to a group of people, we have used PVI and GVI to refer to people/gamers with visual impairment to improve clarity of expression in this article.

suggested that this may be seen as normalising the discourse of disability by presenting PVI as dependent on technology [78].

Whilst deficit-driven approaches have led to valuable innovation to improve quality of life for PVI, recent work has called for a more positive approach which recognises the skills, competencies and knowledge of PVI [27, 119]. Gerling et al. point to the need to involve players with disabilities in development of both entertainment and education-oriented games, and provide recommendations for working with these players [50]. Sighted individuals wearing blindfolds are not a suitable proxy for participants living with VI [98, 100]. Inaccessible games, it is suggested, may be due more to oversight or omission than to a conscious design decision [58]. Audiences with a need for "multisensory types of feedback" are recognised as a "flagship context" for games user research [37].

It is perhaps ironic that more attention has been paid to obscuring in-game information for all players than to techniques for revealing information to PVI. For example the "Fog of War" technique, whereby the game intentionally occludes or reveals terrain information to the player based on their location or line of sight [18, 84] is a popular mechanism to reflect the "limitations of game characters' ability to perceive and monitor the world around them" [72]. In contrast, gamers with VI are already restricted in their ability to perceive objects and events and require mechanisms that reveal features that are obscured to them. A notable approach to inclusion of PVI –although not in the digital game space– is the work of the Meeple Like Us project [59], which provides an accessibility analysis for popular boardgames across eight factors which include visual accessibility. Boardgames provide not only visual but also tactile, "sensuous" appeal [92] and are an increasingly popular leisure activity.

Audiogames

Audiogames [66, 90] are a specific form of digital game developed for PVI, featuring "complete auditory interfaces, so that they can be played without the use of graphics" [45]. These games use auditory cues such as speech, auditory icons (representational natural sounds e.g. the sound of a car crash or of a bleating sheep), and earcons (artificial sounds e.g. beeps, musical tones or sound patterns) to convey information to players [16, 35, 48]. There is no consistent set of earcons that is used across different games [113]; players must learn a new set of arbitrary sounds for each game that they play [45]. Audio mappings with greater articulatory directness [61] may be easier to learn than those which are purely symbolic [48]. In other words, the more a sound is like the sounds experienced in a comparable situation in the real world, the easier it is to learn and remember. Accordingly, a game or setting with a large number of earcons creates additional

cognitive load on players' memories [16]. Unlike a visual scene, sound is temporary rather than persistent; it must be repeated if it is to remain salient [66]. Excessive amounts of audio content may create overload, thereby complicating, rather than simplifying, gameplay [68]. Yet a lack of descriptive audio information was identified by one study as "the biggest deal-breaker for our blind respondents" [47].

Kirke [66] summarises the different types of audiogames, which are indexed at the website www.audiogames.net. Common interaction mechanisms in these games include verbal information, where players are provided with oral instructions on what to do; time-based mechanisms, where earcons indicate when to perform an action; and constrained navigation, where the player's character is limited to moving on a coordinate-based grid-like system [51].

Audiogames have been criticised for failing to offer the full range of gameplay experiences. In a call for positive design [119], Smith and Nayar compare blind-accessible videogames to a wheelchair ramp-enabled library that is filled only with digests of the original books, suggesting that "accessibility alone is not enough" and arguing for what they term equivalent accessibility –allowing people with disabilities to experience the world as others do, "with a similar sense of control (intention) and efficiency as sighted players can" [100]. They identify complexity as a critical element of gameplay that is poorly served by existing approaches to accessibility.

Binaural 3D sound may be used in games to provide directional cues for players [66]. This technique embeds directionality into sound recordings through the use of two high-fidelity microphones which are typically embedded in a dummy head, to emulate "the physical effects of the diffraction of sound waves by the human torso, shoulders, head and outer ears" [23]. Thus, binaural 3D sound allows "simulation of three-dimensional sound of the real source" [67].

More recently, echolocation has been proposed as a navigational tool in virtual environments [4]. Research over the past seventy years has shown that echolocation –using self-emitted noises such as mouth-clicks as well as the ambient sounds generated by a person's cane or shoes– is an effective tool for human navigation [96]. The prospect of supporting echolocation in virtual environments promises an additional tool for PVI, who already use a range of strategies in negotiating in-game virtual environments [4, 103].

3 AIMS AND CONTRIBUTIONS

Previous literature has generally explored games for PVI on a game-by-game basis, with the exception of Kirke [66], who provides a comprehensive list of the most common audiogames played by GVI. In this paper, we set out to explore the habits, opinions and concerns of GVI through a game-agnostic, "in the wild" methodology. We aim to understand the lived experience and practices of GVI in their interactions

with games and play. This research redirects the dialogue of disability surrounding GVI, moving away from an approach of compassion, where design is driven by a perceived deficit. Instead, we orient this research towards a positive, empowering approach, where we make explicit the needs and concerns expressed by GVI [27, 119]. This approach will inform the development of more accessible games through an understanding of the trajectories and practices of GVI.

4 METHODS

Our research comprised an online survey and semi-structured interviews. The participants were PVI who are part of an online audiogame community. The study was approved by the University of Melbourne Ethics Committee (Ethics ID 1851274).

Online Survey

The survey aimed to understand respondents' existing gaming habits, their perception of interaction patterns in their favourite games, and their views on emerging gaming technology, such as VR and AR. The survey was advertised on the website forum.audiogames.net, as the site specialises in audiogames and attracts GVI and game developers.

As someone with a visual impairment, the first author strived to establish a bona-fide relationship with members of the forum by providing answers to technology-related questions. This positioned him as both an insider within the PVI community [15] and an expert in the subject matter, developing credibility within the community for him and, by extension, for the research project.

The survey consisted of 24 questions. A copy of the survey is included in the supplementary material for this paper. The survey contained a series of single-choice, multiple-choice and open-ended questions. Some of the questions regarding participants' gaming habits were adapted from larger surveys by *The Entertainment Software Association* [42] and *Digital Australia* [20]. The survey was built using Google Forms and was tested for accessibility using Firefox 60.0 and the screen reader NVDA version 2018.1. Because PVI may experience difficulties filling in online surveys even when these are accessibility compliant [70, 71], we decided not to make questions mandatory. The survey was piloted with the University of Melbourne Web Accessibility lead, who has extensive experience working with people with disabilities. The survey was available for four weeks and was advertised on the forum on two separate occasions.

Interviews

At the conclusion of the survey, respondents were invited to volunteer for a semi-structured interview. Six people engaged in the interview, which was conducted in English. The

interviews aimed to get in-depth knowledge about interviewees' experiences and perceptions of gaming. The interviews explored interviewees' relationship with digital games, their thoughts on accessibility and games, and the factors that keep them engaged with games. Space was also allocated to allow interviewees to discuss any other topics they felt were important. The interviews were conducted via a medium that was preferred by the interviewees, allowing them to engage in a space where they felt most comfortable. Five interviewees preferred the video-conferencing software Skype and one preferred the audio-conferencing software TeamTalk. However, cameras were not enabled in any interview. While the interviews were scheduled to last around 20 minutes, participants were happy to go over the pre-established time to share their views. We obtained 186 minutes of interview recording in total.

Participants

Participation in both the online survey and the follow-up interview was voluntary; there was no compensation for participation. We received seventeen valid responses to the online survey and were able to contact six out of eight interested participants to take part in the follow-up interview. Participants were 18 years of age or more, spoke English as a first or second language, and had a self-reported degree of visual impairment that could not be corrected with glasses, including low visual acuity (mostly colour perception), loss of central vision, loss of peripheral vision, blindness (some light perception) or full blindness (no light perception). Table 1 shows demographic information of all our participants. Participants 1 through 11 participated in the survey only, and participants 12 through 17 participated in both the survey and the follow-up interview.

As shown in Table 1, participants came from North and South America, Europe, Asia and the Middle East. Only one of our participants was aged between 36 and 45 years while the other sixteen participants' ages fell between the range of 18 to 35 years. Twelve participants were male, four were female and one preferred not to disclose their gender. Ten of the seventeen participants declared the state of their vision as blind with light perception, four are blind with no light perception, and three self-identified as having low visual acuity, relying mostly on colour perception. In order to protect participants' privacy, they are referred to by pseudonyms.

Data Analysis

We analysed the multiple-choice answers from the survey by tabulating responses to individual questions. These results are presented in the section *Quantitative data from the online survey*.

Table 1: Demographic information of participants. All participants completed the survey. Participants 12-17 continued to the semi-structured interview

N	Age range	Name	Gender	Country	Impairment (and onset)
1	26 to 35	P1	Male	No answer	Low visual acuity. Colour perception.
2	36 to 45	P2	Male	No answer	Blind, light perception
3	18 to 25	P3	Female	Slovenia	Blind, light perception
4	18 to 25	P4	Male	United Kingdom	Blind, light perception
5	18 to 25	P5	Male	Turkey	Blind, no light perception
6	18 to 25	P6	Male	United Arab Emirates	Low visual acuity. Colour perception.
7	18 to 25	P7	Female	USA	Blind, light perception
8	26 to 35	P8	Female	No answer	Blind, light perception
9	18 to 25	P9	Male	USA	Blind, light perception
10	18 to 25	P10	Male	USA	Blind, light perception
11	18 to 25	P11	Male	USA	Blind, light perception
12	18 to 25	Juan	Male	Canada	Blind, no light perception (from birth)
13	18 to 25	Marcela	Female	Philippines	Blind, light perception (early childhood)
14	26 to 35	Alberto	Male	Brazil	Blind, no light perception (early childhood)
15	26 to 35	CJ	Prefer not to say	USA	Blind, no light perception (10 years old)
16	18 to 25	Carlos	Male	Austria	Blind, light perception (from birth)
17	26 to 35	Jose	Male	USA	Low visual acuity. Colour perception. Loss of peripheral vision (from birth)

Extended answers from the open-ended questions in the survey and the follow-up interviews were analysed separately with the aid of the software NVivo 11, using thematic analysis and the step-by-step method proposed by Braun and Clarke [22]. Following Braun and Clarke, our first step was to transcribe, read and re-read our interviews [22]. We then followed an inductive approach, whereby codes were driven by the content of the data. Once the data had been coded, we proceeded to search for and identify trends or themes among the codes. These initial themes were then revised, formally defined and given a name. The first author coded all the interviews while two other researchers coded specific interviews in an attempt to ensure consistency and identify all relevant themes. While the individual themes identified by each researcher were worded differently, they encompassed similar ideas, with minor differences in emphasis based upon the framework of expertise of each researcher [9].

5 FINDINGS

The results from the online survey offered a snapshot of demographic information of GVI, frequency and duration of gameplay, preferred gaming device, and preferred types and genres of games. Moreover, responses to the open-ended questions in the survey showed some of the reasons why GVI engage with videogames, and their concerns regarding new gaming technologies, such as AR and VR. The follow-up interviews provided rich insights into the habits, opinions

and concerns of GVI. The themes derived from our analysis included: engagement with games and narratives, tensions of building games that are complex but accessible and appealing to the mainstream, the importance of social trajectories for gameplay, ideas around self-representation in digital games, opinions about accessibility in mainstream digital games, and concerns surrounding emerging technologies, such as AR and VR.

Quantitative data from the online survey

Summary survey results are presented in Table 2. The results in this table correspond to questions that had single choice answers. The relatively high no answer rate to the first two questions may be explained by our decision not to enforce mandatory answering of all questions.

Table 2 shows that more than half of our respondents played videogames at least every other day. Duration of play was mostly more than two hours at a time. The table shows that while six respondents mostly played with others, the remaining respondents said they mostly played on their own. Most respondents reported to use the free and open-source screen-reader NVDA for Windows while playing.

Our respondents played games on computer (16), mobile phone (14), dedicated console (7), and handheld console (2). When asked about the genre of game they played, participants responded: role-playing games (RPGs) (15), platformers (10), fighting games (10), strategy games (10), shooters (9),

Table 2: Responses to single-answer questions from the online survey

Question	Answer	Count
How often do you play videogames?	Every day	6
	Every other day	6
	Once a fortnight	1
	[no answer]	4
When you play, for how long do you usually do it?	30 minutes to 1 hour	1
	1 to 2 hours	4
	2 to 3 hours	2
	3 to 4 hours	3
	4 or more hours	3
	[no answer]	4
With whom do you play videogames most often?	By myself	11
	With family members	2
	With online friends	4
What type of game do you play most often?	Text-based games (MUDs)	3
	Audiogames	11
	Mainstream games	3
What assistive technology do you use when playing videogames?	NVDA screen reader	13
	Other PC screen reader	1
	In-console screen reader	2
	None	2

puzzle games (4), trivia games (3), educational games (3), racing games (1), and horror games (1).

Qualitative data from the online survey

Our analysis identified different aspects of the gaming experience that respondents enjoy. Two respondents referred to the narrative of the game: "the great narration and stories you're able to find, plus the regular updates" (Carlos), "Story and actions" (P2). Others highlighted the level of complexity of the game: "The combination of exploration/discovery with the challenge of survival" (CJ), "Plenty of areas to explore, with new ones being added regularly" (P3), "Complexity, attention to details, and replayability" (P6), and "The mainstream-like feel" (P4). These answers foreshadow some of the themes that reappeared in the follow-up interviews.

Respondents were asked about the cues that games use to convey information. Our analysis identified three modes: text, sounds and radar. Text referred to the ability of the digital game to present information in such a way that is compatible with screen-reader software. Sounds referred to the use of auditory icons and earcons across digital games, and radar, as explained by P4: "functions like a cane, playing different sounds if it finds open space, walls, or other objects".

Respondents were asked about their experience with AR and VR. None of our respondents had experienced VR before; however, P7 said they "would be open to it if it could even work for me" and Juan "would really like to [try VR]!". When asked if they had tried AR experiences, four respondents claimed to have tried the popular *Pokémon Go* game and found it completely inaccessible. In the words of one of our respondents: "of course the development team had not considered the fact that a blind person may be able to play".

Follow-up interviews

The semi-structured follow-up interviews allowed us to explore in more depth the opinions and concerns of GVI. Key themes related to: the personal appeal of games –what participants found engaging, or the story elements that they preferred; the social and gaming trajectories and relationships that bring them into and keep them in the gaming hobby; the way that they are represented in games; the perceived tensions around complexity and accessibility; and the challenges and promise associated with new technologies.

Engagement in games. Analysis revealed there were several factors that attracted GVI to games, namely curiosity, engagement, and ability to affect the game narrative. Marcela was driven to digital games by curiosity: "I was just curious about playing games, because I know there's a lot of games for sighted people and I was curious about how about us? How can visually impaired play computer game?". CJ was attracted to games because of the "engagement" games provide: "It's kind of hard to explain I guess. It isn't necessarily how complex, or intuitive, or anything like that so much as how engaging the game is". On a similar note, Juan linked engagement to the opportunity to direct the game's narrative, commenting that "affecting the story" keeps him engaged: "I don't even need a massive world, or anything like that, just something that feels important, like I'm doing something, like I'm affecting the story, you know?".

Engaging both GVI and sighted players was a challenge recognised by Juan: "[An audiogame] won't appeal as much to sighted people, there's almost no way to please both, which kind of sucks". Alberto, however, had a different opinion: "let's use *Swamp* as a good example. Again, because *Swamp* has minimal, but still it has graphics. And, I have lots of friends, and nephews, and a bunch of sighted players playing alongside us".

Analysis revealed that engagement changed over time as the visual capabilities of players changed. CJ explained that they "got better at *Mortal Kombat 4* after I lost my remaining vision, because I wasn't distracted by how difficult it was to tell things apart". This range of different forms of engagement that GVI enjoy in games highlights the need for a diversity of game styles and interaction methods.

Stories and narrative. Some of our participants considered the story a key element for videogame engagement. For Juan, games where he affects the story were "the kind of genre I would like the most", but "there's very few audiogames that really have a story". Juan commented that he particularly enjoys MUDs because "they've got lots of story". Carlos shared this sentiment:

"the more story there is and the more control you have over it, the better it is in my opinion. So, I really like story driven games. There aren't that many audiogames that change based on your decision unfortunately, but the ones there are, I enjoy a lot".

On a similar note, Jose said: "in audiogames so far, we haven't really had much story stuff. It's usually just game-play elements or it's a very minimal story". For these players, the game narrative supports and extends the gameplay experience.

The tension of complexity vs accessibility. Participants described a tension between a game's complexity and its accessibility. According to Juan, "You've got to make a game more crap if you really want to make it easier for blind people. You've got to make it more simplistic." In his opinion:

"Most games for blind people are made by someone else that isn't blind or hasn't been a gamer for a long time. [Games for PVI] are just really easy and simplistic when you actually get down to the action elements. They... are usually quite easy and don't have much challenge or replayability to them."

Alberto, on the other hand, noted: "You don't have to force a downgrade on a game just for it to be accessible". CJ cited a different issue when handling complexity, noting that "There are like some types of games where they use challenges that don't really map very well to audio in terms of their complexity and their speed."

Juan and Alberto both provide examples to support their opinion. For Juan:

"AHC [*A Hero's Call*], no sighted person would give a damn about that game. They'd be like, 'Oh, that's cool, it's playable for blind people', but no sighted person would be like, 'I want to play a game that basically uses modern sounds but has the whole game systems and story and stuff from the nineties'".

Referring to *Swamp*, a game with minimal graphics, Alberto said: "So, it's basically everyone on the same ground, there are no advantage for being sighted, or for being visually impaired in the game."

Older games were perceived as simpler by CJ, although this perception may be coloured by deterioration in vision:

"there was a period where I had some vision. It was still really limited... but I could see well enough to play *Mario* and games like that where they were not necessarily too deep, where the graphics were simple with the cartoonish colours and the not overly complex".

Players' perceptions of the relationship between game complexity and accessibility are clearly linked to the types of games that they play as well as to the situation of play.

Social trajectories and gameplay. Interviewees were introduced to different types of games by different people. In the case of Juan, "My dad [who is also blind] played [audiogames] a bit... sometimes I'd watch him play something". However, a different person introduced Juan to mainstream games: "I have a very good [sighted] friend but I barely ever see him anymore... he's basically my only access to mainstream games... and we would play *Super Street Fighter*, which I was never very good at, and *Mortal Kombat*, and *Injustice*". Marcela was introduced to audiogames by a friend: "at the end of year 2016, I was invited by my friend ..., and from there, I learned lots of games". It was similar for Alberto: "We tended to watch our friends, and family play when we were younger, like *Resident Evil*, *Silent Hill*, and stuff like that", and for Jose "I was over at a friend's house and he told me about [MUDs]". CJ, however, was introduced to games by a professional worker: "My brailist at the time introduced me to audiogames. The person who would translate my school work assignments into braille, had a bunch of kind of random software that they gave me".

According to Juan, the community of GVI is quite close. In his words:

"there's three or four games that blind people really tend to gravitate towards right now. *Swamp*, *Redspot*, *STW [Survive the Wild]*, those three. You're almost guaranteed to find people that you find on audiogames.net and that you email or Skype with. It's a close-knit community. Everybody pretty much knows everybody or can remember them if they talk to them for a little bit".

Marcela said that when online, she "plays with her friends" and "has no experience playing with strangers". Similarly, Carlos plays with online friends, but he also plays "with a couple of people I know, IRL [in real life]". Marcela added that "we play together [with online friends] and sometimes just talk about random things". In these comments, interviewees have shown the value of social relationships in gameplay, the need for a gate-keeper, and a sense of community.

Self-representation in games. Participants had different attitudes regarding self-representation in videogames. In Juan's opinion, "I'm not into role players, so I don't really care about avatars. I just choose a username that I use on other stuff so that people know who I am, and I can find friends easier that I already know". Similarly, Carlos explained that in the game *Crazy Party*, "The name is the only way [to identify other players]". Referring to a first-person RPG called *Dark Passenger*, Alberto mentioned: "[the experience] is more immersive, because you are from the character's perspective. You are on the character's skin".

CJ highlighted the limitations for self-representation provided in audiogames:

"Something that I kind of wanted to see, but I'm pretty sure it isn't actually never going to happen is that there's a bunch of different types of armour in the game. It would be things that can have really distinct sounds when the players are moving. There's a leather jacket versus plate armor versus a SWAT armour. They're all like really different. If you were to have the sounds of that with the players' movements, I think that would make it a lot more interesting because you could hear people sound quite distinct... But it's still something that I think would help a lot with distinguishing characters, keeping them unique."

In this way, GVI could be identified by personalized audio icons or avatars.

Accessibility in mainstream platforms. Overall, participants showed positive attitudes towards accessibility in mainstream platforms. Carlos noted, "I love the fact that things are happening now. There has been a large step forward in accessibility in the last year and a half. We still have a long way to go, but it's like what's there is already great". Alberto felt the same way: "It's improving slowly, but it's better than nothing, I guess", and so did Jose: "I think it's getting better, but, of course, there's still room for a lot of improvement." Juan and Carlos both cited the Xbox as example of good accessibility decisions from mainstream companies. Carlos highlighted the following: "Just recently, the first TTS (text-to-speech) game for Xbox got released... Even if it's just a *Solitaire* game, it'll show other developers that this is possible, and they can do this". Juan praised the Xbox Accessibility Controller for its mainstream-like implementation and aesthetic:

"They took time to make it cheaper and also gave it a lot of ports. They made it not insulting in its branding or its marketing and they made it cool looking, which is pretty big. I thought, 'hey these guys took a lot of time to do that, that's awesome'."

Alberto talked about EA as a company that was concerned about accessibility: "We have big companies like EA. They are very concerned about how the games they are producing are getting to the public. So, a few games like *UFC [Ultimate Fighting Championship]* are getting accessibility treatment".

CJ, Alberto, Carlos and Jose agreed that fighting games "are very accessible from out of the box" (Alberto). Jose explained how these games were made accessible: "The menus are now read out loud... I was listening to other people playing the latest *Mortal Kombat* games and they have different sound cues to let you know when certain things happen".

Our participants also acknowledged platforms that are not as accessible. Juan noted that "Steam is a nightmare to get around". Regarding the game development platform Unity, which is not accessible to screen-reader users, Carlos said "If we had a language as powerful as Unity without the accessibility problems, we could have some really good games out there already". Our analysis showed that participants were well aware of the steps towards accessibility that the gaming industry is taking, as well as particular environments that were problematic for GVI.

Experience with virtual and augmented reality. Our analysis revealed that, while our participants have not had any experiences with VR, some yearned to try these technologies. Marcela expressed her desire to participate in VR experiences. She said, "I really wish there was a game like that", referring to the combination of head-tracking and 3D binaural sound. "3D sound is more fun so that you can imagine you're 3D playing on reality and not just computer". CJ saw potential in the ability of VR headsets to track a person's head: "I have figured if you actually have head tracking, it would be easier to keep track of how you're oriented, so that would probably help."

Carlos had experience with the popular AR game *Pokémon Go*. He described the experience as follows: "With VoiceOver [the default screen-reader in iOS], it is completely inaccessible, so you have to have someone else there. And they just played, and I just watched and went with them... It would be something I would really love to play if I could". His final comment on the issue was this: "My main concern with VR and AR is that it will leave blind gamers in the dust even more, as things transition to very VR-based games and simple graphical games aren't enough anymore".

6 DISCUSSION

Technology is often seen as a means to 'normalise' individuals with an impairment by compensating for what are presented as deficits [78, 79]. Rogers and Marsden have argued that the rhetoric of compassion that underpins this approach to research can lead researchers to design technologies which they think the disabled person needs [91].

This worldview can alienate the person with a disability, making their true desires and aspirations secondary to their bodily limitations. Instead, researchers have recommended that the HCI community should follow a rhetoric of engagement and discourse of passion, and design for empowerment rather than compassion [79, 91]. Following this path could enable relationships with technology that are "neither mastery and control nor passive acceptance, but an experience of being immersed in intimate interactions" [79]. Indeed, our participants demonstrated a passionate relationship with their games, playing from a very early age, some dedicating more than four hours a day to playing videogames or, in the case of Carlos, playing the same MUD for over thirteen years.

The importance of games to PVI

Our participants rely heavily on audiogames, which offer an accessible, familiar, and enjoyable interface for their gaming. They describe their engagement with games and can recount their personal histories of gameplay. Survey respondents invest considerable time in gaming, with two thirds of respondents playing games at least every other day and eight of thirteen respondents playing for two or more hours at a time.

Playing games is a goal-directed leisure activity [81]. Studies of "Gamer Identity" have found that needs for competence, autonomy and relatedness are closely correlated with the individual's social identity as a gamer, and that enjoyment and connectedness are important to both casual and heavy gamers [81]. This is echoed in our interview data through the discussion of the particular activities and game elements that participants found engaging, as well as in the way that they described their experience of sociality.

One topic that did not appear in our findings was any desire on the part of the interviewees to present themselves as a blind character in-game, although Carlos commented that there are stereotypical blind characters in *AHC* and *Blind Legend*. It was unclear whether this was due to the desire to present an idealized self (as shown by some older adults [26]), whether it was an oversight, or whether it was due to a lack of in-game supports for blind characters. Research with young people using powered wheelchairs suggests that although users with a disability might not prioritise representation of that disability in an interface, they may nevertheless value that representation if it exists [49].

Social play

Gaming is known to be a highly social activity [41]. There is a considerable body of research that explores the dynamics of groups on MMOs and argues that multiplayer capabilities improve or extend the gaming experience [28, 39, 101, 114].

Moreover, others have argued that social interactions in digital games are beneficial to gamers' social networks in the virtual world, as people establish and maintain social ties [103, 121]. Game aficionados frequently get to know others in-game [40, 101], accruing social capital through group membership [33, 110]. Comments such as Marcela's observation in the section *Social trajectories and gameplay* that sometimes she gets together with friends to play but instead talks "about random things" echo similar reports stressing the sociality of gaming, describing face-to-face gaming evenings "where no actual gaming took place because we just started talking and had a fun evening." [92].

Participants described the trajectories of their involvement in gaming. Many talked about the people —friends, family or professionals, who introduced them to games and who played with them. Juan, for example, described a sighted friend, who he no longer sees regularly, as having provided his "only access" to mainstream games.

Many of the games our participants engage with have multiplayer capabilities. With one of our participants defining the community of GVI as "close-knit", future research could explore in more detail the types of social interactions that are targeted to GVI. For example, research on streaming play typically focuses on the technology [1, 116], the selection of games [34], the visual spectacle [102], and on chat interactions [99]. In our interviews, however, Jose described listening to other players playing *Mortal Kombat*, observing that sound cues may help provide an even ground for players with different physical abilities.

Mixed-ability players

Although we found some research interest in audiogames [66, 90], there is little to no research that examined the involvement of sighted players in audiogames, or of players who also experience another form of impairment such as hearing loss. Both of these groups are identified in a post to the audiogames.net forums by the designer of *Swamp*, who notes the additional accommodations that he has designed for blind players with hearing loss, and that he has made changes to improve accessibility "for our minority player-base, and by that I mean those silly sighted players" [5].

We found disparate views from our participants about whether games can be designed to be both accessible to GVI and challenging for sighted players. Given this, it would be valuable for future research to explore the thoughts of sighted players regarding audiogames. Games like *Musicraft* demonstrate that it is possible to design audiogames for both VI and sighted players [66], although these have yet to become mainstream. Moreover, it would be interesting to explore the interactions between sighted players and GVI, as well as the experience and needs of players with multiple impairments.

Two recent industry reports [20, 42] found that a large percentage of gamers are children and teenagers. This points to a need for further research on this group of players, which could explore the dynamics and needs of younger GVI. Moreover, we received five responses from GVI aged under 18. Because of constraints around our ethics approval, these respondents were not allowed to answer the questions of the survey once they identified their age, but this interest shows the eagerness of younger GVIs to share their views on digital games and accessibility.

Reducing barriers to play

Tensions of PVI integrating to mainstream activities such as regular employment, and the workarounds they rely on have been explored in depth [109]. Additionally, projects have proposed both general guidelines for accessible game design [58] and more specific guidelines, for example the *Meeple Like Us* guidelines to accommodate PVI playing tabletop games [59]. These efforts show that with the right support and adaptations PVI can participate in any gaming activity regardless of their impairment. As Alberto puts it, with the right support "basically everyone [is] on the same ground, there are no advantages for being sighted, or for being visually impaired". This equal footing may enable PVI to experience the immersive interactions associated with the discourse of passion [79] in the same way a fully able-bodied player engages with games.

While the research community has made many efforts to address the gap of inaccessible games, with examples such as *PowerUp* [103] or *Blind Hero* [117], these usually fail to reach the mainstream [86]. Given the renewed interest of the game development industry in producing accessible games, as explained by our participants, there is an opportunity for industry and research to find new and imaginative ways to reducing barriers to play.

Realistic auditory representations

Extensive research has explored the role of avatars as mediators of interactions with virtual worlds [25, 26, 62, 87]. Visual aspects of avatars have driven much of this research [38]. Studies have explored the use of photorealistic avatars [87], avatars with expressive facial animations and real-time hair simulation [24], and avatars with customisable walking gait [80]. However, little to no attention has been placed to the aural customisation of avatars. As CJ explained, providing unique sounds to players based on specific game elements such as armour "would make it a lot more interesting because you could hear people sound quite distinct". We believe there is an opportunity to explore the impact of providing aural customisation of avatars to both sighted and VI gamers.

Lack of complexity

Our participants valued complexity in games, although some felt that games for PVI tend to be overly simplistic. A possible reason for this perceived simplicity could be the tendency for sighted individuals simulating VI to consistently underestimate the capability of players living with VI [98, 100].

One difficulty in extending complexity is the fact that images are persistent, where sound has a distinct beginning and end. In order for a sound to persist, it must be repeated. This adds to audible clutter and, thus, to the cognitive load required to understand and play the game. Further work is required to understand the balance between providing enough sound to support GVI and over complicating the process required to understand the game state [68].

Concern about emerging trends

Two recent surveys [20, 42] provide a detailed analysis of gaming trends in the US and Australia, highlighting trends within the broader gaming community which may affect GVI. Both reports note a growth in the use of VR devices, with one report suggesting that "1 in 3 of the most frequent gamers said they were likely to buy VR in the next year" [42]. This contrasts with the attitudes and thoughts of our participants, who have had no experience with VR and fear that this technology would "leave blind gamers in the dust even more". This suggests that accessibility features are not keeping pace with the speed of technological change, aligning with concerns that even existing accessibility technologies fail to capture the broad range of experiences and interactions available to sighted players [100].

Longevity of older technologies

The first MUD is documented to have appeared in 1978, as networked computing became popular [13]. Through the 1980s and 1990s, MUDs were associated with technical prowess and unruly university students misusing valuable network resources [12, 43]. However, as computing moved towards graphical user interfaces, MUDs evolved into MMORPGs [13]. While it is hard to imagine sighted players engaging with text-based games that are built on forty-year-old technology, MUDs have found a new player base in the community of GVI.

Reflecting the importance of narrative to these players, Carlos, Juan, and Jose agree that MUDs allow for the creation of richer stories than most audiogames. This highlights the importance of applying a multi-modal approach to communicating the state of the game world and the available options. The text-based interface, which is compatible with the screenreading technology that PVI are already using in other aspects of their lives, is particularly well-suited to the audiogame format and allows interesting narrative and

gameplay without restricting the complexity of the story and interactions.

7 CONCLUSIONS

In this paper, we have exposed the habits, opinions and concerns of a group of gamers with visual impairment (GVI). We have found that, just like their sighted counterparts, GVI build diverse histories and social trajectories through gameplay. However, unlike their sighted counterparts, GVI must confront a series of barriers to gameplay: limited options of self-representation, a perceived lack of complexity in games, the necessity for engagement with decades-old text-based technologies, and fears of being "left in the dust" by new and emerging technologies such as VR and AR.

By exposing these concerns, we hope to inspire future work that pays closer attention to the needs of diverse groups of players. We expect that this work will create awareness of the need for a rhetoric of passion, where deficit-driven design is tempered by a positive-design approach that focuses on empowering immersive and enjoyable interactions that are equivalently accessible to both PVI and sighted players. Rather than seeing disability as something that needs to be normalised, this approach recognises the skills and knowledge of PVI and demonstrates the practices and opportunities that GVI communities are already embracing.

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