Research Methods in Design & Digital Media

Literature Review:

Virtual Playgrounds For The Blind

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Introduction

In a world of expanding technical advancements and virtual realities with their imaginative playgrounds rich in graphical textures for our minds to freely explore, how would you share the same enjoyment as others within the same space without your sight?
For a long time, video games have been exactly that, visually driven by the increasingly detailed moving picture. Leaving members of our society, who can not rely on visuals, in the lurch.

People who live with a visual impairment, are often left with no alternative to their own ingenuity when wishing to share the same experiences as the rest of the gaming community. There are varying degrees of visual impairments and they can differ from individual to individual. Players with a small degree of sight where they may still be able to make out shapes or colour differentiation may use a screen enlarger, which is an attachment that clips over a monitor or television screen. While others whom have a heavier sight deficit will rely heavily on audio cues, talk to text and apply their own perishable tactile labels to their flush PC keyboards and controllers, using anything from raised geometric stickers to printed braille sticky plastic labels that wear down through use. All of which can arguably prevent the desired level of the player's immersion.

How then may we, as game makers and as the gatekeepers to interactive imaginative play, encourage and include these members whom are visually impaired to actively play within the imaginative playgrounds we create?

Once identified, this could revolutionise the way in which future games are designed and developed throughout the games industry.

Within this literature review we will look at the navigation of three-dimensional spaces through two-dimensional audio feedback, three-dimensional audio(binaural) feedback and the combination of audio with haptic feedback. From here we will discuss the depths of immersion connected to these methods of navigation without visuals, with their success and pitfalls.

Keywords:

Binaural, Navigation, Cognitive Mapping, Haptic Interfaces, Blind, Visual Impairment

Navigating Three-Dimensional Space

From when we are born, through observation of those around us, we learn key life skills that if you are fortunate enough may never have even considered as a 'skill'. Such as learning to crawl, to walk and yes, talk. We watch the shapes of our guardian's mouths to form words, the balanced timing of one foot passing to another to get from A to B. People who are visually impaired go through the same process, although instead listening for cues and through touch.
In terms of navigating a three-dimensional space in everyday life, if you have a visual impairment, you are taught how to determine depth of steps and distance of physical obstacles through using a cane, assistance by a companion's elbow, counting paces, listening out for potential dangers (i.e when crossing a road) and in some cases a Guide Dog to assist you on your journey. In recent years, a number of case studies have been done to both train the visually impaired to navigate an unknown space and to grasp how they create what is referred by Merabet et al.(2012)(2012) as a"spatial cognitive map" .

Merabet et al.(2012)'s study was comprised by two experiments to teach two groups of people who had lost their sight by the age of three, how to navigate one large unfamiliar indoor layout. they developed what they call an "Audio based Environment Simulator" (AbES), which used an architectural floor plan of a real three-dimensional space set up to resemble a monster dungeon utilising binaural cues as a means to tell players their proximity to obstacles (roaming 'monsters') and objectives ('jewels). In this experiment, players were asked to locate all the 'jewels' before the monsters hid them again.
While the second group, referred to as the "'directed navigator' group", "were explicitly taught the spatial layout of the building using AbES through a series of pre-determined paths with the assistance of a sighted facilitator." Before they were given instructions "to exit the building using the shortest path possible from a predetermined starting point."
Merabet et al.(2012) conclude that those who fell into the 'gamer' group "demonstrated superior performance […] by using the shortest route possible (despite a variety of route possibilities)" while the 'navigator' group remained with the longest route. Merabet et al. (2012) hypothesised that perhaps through using a gaming approach, the blind are able to conjure "visuo-spatial imagery". Collins (2013) confirms this theory in her case studies of '*Real Sound-No Regret*' and '*AudioDoom*' where she concluded that "even without visuals, audio based games create a mental space in the player's mind that the player can navigate through their mental mapping of the game's environment."

Lava and Mioduser (2008) examined how the blind create a cognitive map of an unknown space through using both auditory and haptic feedback. Their research was carried out quite similar to that of Merabet et al.(2012) where they too split their participants into two groups. the "Experimental" group to explore a VR version of a space, the "Control" group - were each given the task of roaming the real version of that same space. Both groups' subjects conducted the experiment individually and all were required to report back to Lava and Mioduser (2008) with what they found within the space and show where each object in that

space was located. All findings were captured through the methodologies of the examiner's observation, open interviews and a modelling kit - for tactile mapping. The "Experimental" group in particular were given a haptic controller, known as a "Force Feedback Joystick (FFJ)" and three specific audio cue types that were attached to different objects within the vicinity; 'Labels'- such as hearing "bird chirping at a window", 'Explicit names' - hearing someone say "first Door" as you approach and a 'Guiding Agent' that would warn of corners and close proximity to obstacles.
Lava and Mioduser (2008) found that neither group were 'prefect', as the "Experimental" exceeded in "describing [obstacles] components and their locations", however they didn't do as well in "accurate[ly describing] the room's size and shape."as the "Control" group. Finally concluding a needed composition of both haptic and auditory guidance, for true independent navigation in unknown space. Confirming Collins'(2013) statement; "sounds on their own can evoke images and have corporeal associations with their causality"

From reviewing both Merabet et al.(2012) and Lava and Mioduser (2008)'s research and their findings, we could safely attain that for game design purposes, that haptic interfaces and audio each play a crucial part in creating a 'playable' cognitive map of our imaginative virtual playgrounds.

Johnston (2014) argues that the importance of audio in games and of games themselves have been grossly overlooked, as they "[suffer] from a double marginalisation, with video games generally disregarded as serious objects of academic inquiry, coupled with widespread 'deafness' to sound." To this we could concede to agree, sound is often perceived as the 'support class' to a visual presentation within video games, when they are a driving force all of their own.

From reviewing each author's article we can arguably state that the term 'sound' is an umbrella covering an array of audio types, each with their own distinct purpose. Some of which we have already covered through Merabet et al.(2012) and Lava and Mioduser (2008), which it follows; *Binaural* - the perception of three-dimensional space with directional audio, "*Guiding Agent*" - vocalised descriptor, *Player Generated* - created by the player's character such as their footfalls, *Triggered* - timer based or attached to a game object's collider and A*mbient* - atmospheric and not directly attached to a game object. This leads us into the questioning of 'how do we keep players engaged and grant them the desired depth of immersion?'

What Affects Depths of Immersion?

Adler (1996) in his book, '*Virtual Audio: Three-Dimensional Audio in Virtual Environments'*, raises the issue of what he coins as the *'Cone of Confusion'(1996).* To understand this, we must first understand that his research was based off of the functioning of the human ear. Adler (1996) refers to what he calls the *'Interaural axis',* being the axis that runs from your left ear to right ear. On this axis you have what he terms the '*Interaural Time Difference'* (ITD), the indication of a sound source being closer to one ear over the other) and the *'Interaural Intensity Difference'* (IID), the intensity of sound affected by the "shadowing of the head" where a sound may appear louder in one ear over another based on the direction of the sound source.

*'Cone of Confusion' Adl*er (1996) defines as when either the ITD or IID increase in intensity or time leading the sound source to appear as though it's moved further away, while in fact the source is still in its original position. When designing a three-dimensional space heavily reliant on binaural, it is crucial that the *'Cone of Confusion'* is avoided. Interestingly Adler (1996) highlights different sound wave behaviours that would increase the chance of a deeper player immersion. These behaviours are; Diffraction - the bending of sound over objects that do not obstruct that passing of waves, Reflection - the reverberation of sound bouncing off a wall, *Absorbance* - the level of sound absorbed from different material, *Resonance* - the amplification of sound due to the locality, and *Transmission* - described as "the rumbling type sounds your neighbours seem to cause." Additionally Adler (1996) notes that when referring to three-dimensional audio, the "lag" in between a player action and a program, such as a game, be "no more than some ten milliseconds (20–50 Hz), otherwise the user gets frustrated that his movements and actions are not responded upon, and true immersion can never be reached."
Collins'(2013) following statement backs up Adler's (1996) findings;

> "Sounds are commonly used as feedback to acknowledge an event. the relationship between the input and output is likely to be synchronous[…]If [the player presses] a button and nothing happens right away, [they are] likely to be confused."

Another case study conducted by Collins'(2013) surrounded the iPad game, '*Papa Sangre's',* that composed of both binaural audio and a basic visual interface for player movement. She described the utilisation of the player generated sound and its cause and effects as; "more frightening than most games [due to] the lack of images" as the premise behind '*Papa Sangre's* 'was to collect keys without being detected by monsters, if detected you died.

Conclusion

Then as game makers and as the gatekeepers to interactive imaginative play, we can conclude that by the understanding of the various types of audio under the umbrella of 'sound' and their purposes in portraying space, we can evoke a convincing cognitive map in the player's mind. Coupled by the development of a new tactile-friendly haptic interface, a new immersion level will be reached. Therefore, player's whom live with a visual impairment will enjoy actively playing within the imaginative playgrounds we create in the future, creating an inclusive gaming community.

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