Transdiegetic Sound and auditory immersion in an asymmetrical cooperative game

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Declaration

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

This research is looking to determine how sound interaction, in particular transdiegetic sound, as a core mechanic affects player immersion in an asymmetrical cooperative game. Sound design is crucial for increasing player immersion within single player game experiences, but the issues arises in a multiplayer context where communicating with other players can break this in-game immersion

There is rich potential of exploring the game design possibilities of separating the sensory modalities between two players and exploring how the restricted information is conveyed and consequently how this affects player immersion. This research expands upon this by examining the interplay between four game design patterns; transdiegetic sound, player communication, asymmetrical gameplay and immersive experiences.

This project developed a game which requires one player to wear a pair of headphones and be prevented from viewing the game screen. The other player is able to see the game screen and have the controls to move around the game environment but is not able to hear audio cues from within the virtual space; this only being audible to the player wearing the headphones. The research suggests that the novel design approach highlights how current methods of measuring player immersion such as questionnaires may not always be appropriate due to the assumptions they contain within the questions they ask.

The results also suggests that whilst the relationship between transdiegetic sound and asymmetrical gameplay may not appear to be significant, there is an interplay between these mechanics that influences the immersive experience for the player. This project proposes that future work considers this interplay and avoids attempting to analyse how a design pattern determines player immersion in isolation but that it considers how it behaves it relation to the other design choices within the game.

Contents

Introduction

Background

Although the term transdiegetic sound is relatively new, the background for the concept is not. The idea of diegetic and non-diegetic sound has been used for many years in the medium of film and theatre. Sound is called diegetic when its source is visible or implied in the world of the film, whereas sound is said to be nondiegetic when its source is not present or implied in the narrative universe. (Gorbman, C. 1980) for example, the car radio within a movie in which the characters can hear would be considered diegetic, whilst the instrumental musical score of the film would be considered non-diegetic.

However, sound in video games often deviates from these categories; the reason for this is that unlike a film, when a player hears nondiegetic sound, the information carried with it can influence what happens in the game world, such as a musical cue indicating to the player that they are approaching dangerous territory. This leads to an interesting situation in which although the avatar does not hear non-diegetic sounds, they may react to these sounds because of the control link between player and avatar. Jørgensen (2008) coined the term transdiegetic sound for this characteristic frequently found in the sound design of games which cannot be clearly determined to be diegetic or non-diegetic.

Whilst there has been a body of research on the relationship between sound and immersion in video games, relatively little has been done on how transdiegetic sound in particular affects player immersion. This concept of transdiegetic sound also never considers the reversal of the relationship between the player and the game space – that in which voice communication from the player acts as an input device to the virtual environment and in turn provides information to the game world. Whilst there has been extensive research on voice input and player communication in games, again there has been relatively little work exploring how this affects player immersion.

Asymmetrical gameplay refers to the design of a multiplayer game which features different gameplay mechanics for different players, sometimes using different input devices. This also includes the concept of asymmetrical cooperative gameplay, as some games don't feature a traditional cooperative mode that makes the players equal partners but allows a second player to participate in the game to assist the first player albeit with significantly different gameplay mechanics.

Games with cooperative asymmetrical design tend to foster player communication, because they use design patterns such as incomplete information to encourage players to discuss and work together, sometimes requiring this communication to gain a full understanding of a challenge or puzzle presented in the game in order to complete the game objective.

This design pattern naturally lends itself when developing a game which intends to include high levels of player communication, because the asymmetrical nature of information provided facilitates the need for players to discuss, as having incomplete information would make the game difficult to complete otherwise.

Motivation

The reason for expanding upon the background of research is that developing an immersive experience for players has become a hot topic in the game development environment, and as such it is has grown to be a popular area of research in the academic community to measure the players level of immersion during gameplay. (Terzioglu, Y. 2015) As noted though, current methodologies for measuring player immersion can be difficult to implement when playing games with niche design patterns. These methods tend to place emphasis on elements in games which may not always be present in the games design, such as graphical imagery. This research aims to explore the possibilities of providing an immersive experience irrespective of whether the players are playing the game with graphics or using audio only.

These concepts of player immersion, transdiegetic sound, voice communication and asymmetrical gameplay are four areas of game research that have been explored in depth but never in terms of the relationship they may have with each-other. The motivation for examining this interplay is because of the nature of the gameplay experience, and how a player's sense of immersion is rarely determined by a single modality. By providing a novel approach to measuring player immersion and examining the relationship of these concepts, it may be possible to expand upon the existing methods for analysing immersion and provide interesting gameplay experiences to the player.

Research Question

The research will attempt to answer the question of what extent transdiegetic sound has in terms of influencing player immersion. In extension, this work will also examine how asymmetrical gameplay can generate and facilitate transdiegetic sound within the game space.

The aim of this research question is to attempt to determine what relationship, if any, exists between these game design patterns, and how this relationship can have an impact on the overall experience of the players.

Objectives

To determine if the questions proposed by this research have been answered satisfactorily, it is useful to highlight objectives of the work and refer back to them to see if they have been achieved.

To examine the extent transdiegetic sound has on player immersion, a game shall be developed with certain design principles to provide instances of transdiegetic sound to the player. In this instance, the game will require voice communication between multiple players to be the source of this transdiegetic sound. Once the play experience has been concluded, the players sense of immersion will need to be measured, with a focus on if and how the transdiegetic sound influenced their sense of immersion.

This may require development on existing frameworks for measuring player immersion, due to the novel design approach of the research game. We can also examine how much of the transdiegetic sound produced during gameplay is a result of asymmetrical gameplay by using a thematic analysis approach when reviewing player responses and determining if the discussion of transdiegetic sound relates to asymmetrical gameplay.

Thesis Structure

This document will first examine previous literature concerned with the four main areas of game studies that this work is concerned with; concepts of player immersion, transdiegetic sound, voice communication and asymmetrical gameplay. These themes, and others that are relevant to this topic, will influence the design of the game, which will be discussed accordingly. This is followed by the methodology section, which detail how the study will be carried out, and how participants will interact with the game that has been developed for this research.

The results section then notes the findings of the study, and discusses the implications of these results in relation to the research question and the emergent themes. Finally, the thesis shall conclude with a summary of the project, examining limitations of the research and how it can be expanded upon.

Related Work

Defining Immersion

Before the discussion of how audio relates to immersion can be had, the idea of immersion in game design needs to be defined. Many players, designers and researchers discuss immersion, but the definitions vary. Brown and Cairns (2004) used Grounded Theory to develop a theory of immersion. After presenting this model, Brown and Cairns relate it back to variety of other writers and concepts, such as Flow. (Csikszentmihalyi, M. 1975) While one might question whether these concepts really make up a scale, it certainly seems an improvement of previous scattered and conflicting notions of what immersion is, and an attempt to bring different concepts together.

Research suggests that the gameplay experience and immersion into a game are multidimensional phenomena. (Ermi. L and Mayra. F, 2005) proposes that immersion is a many-faceted phenomenon with different aspects that can appear and be emphasised differently in the individual cases of different games and players.

In the Gameplay Experience Model, gameplay is represented as interaction between a particular kind of a game and a particular kind of a game player. The model is a representation of key elements that structure the gameplay experience. It is not intended to be used for an extensive analysis, but rather designed to guide attention to the dynamics that are involved in the interaction between a player and a game.

The complex organisation of a “game” and a “player” are particularly left vague here, as the focus is on the structure by the interplay, rather than on an analysis of games or players in themselves. The gameplay experience can be perceived as a temporary experience, in which finally the interpretation made by the player takes into account also other information such as peer influence, game reviews and other frames of socio-cultural reference.

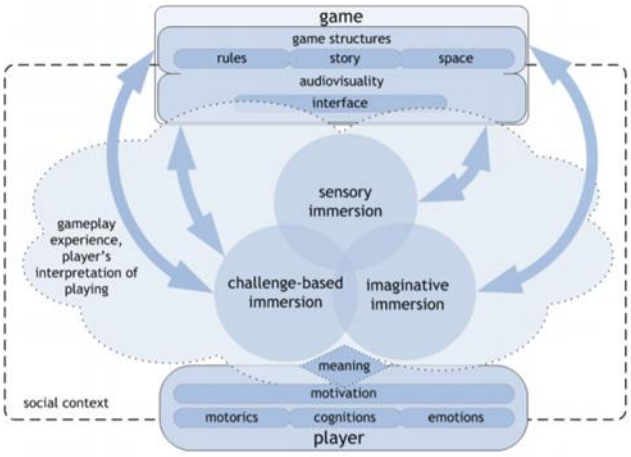

Figure 1- SCI-mode (Ermi & Mayra, 2005) identifies the three key dimensions of immersion that are related to several other fundamental components, which have a role in the formation of the gameplay experience.

The first dimension of a gameplay experience that Ermi. L and Mayra. F distinguish is the sensory immersion related to the audio-visual execution of games. This is something that even those with less experience with games can recognize: digital games have evolved into audiovisually impressive, three-dimensional and stereophonic worlds that surround their players in a very comprehensive manner.

Large screens close to player's face and powerful sounds easily overpower the sensory information coming from the real world, and the player becomes entirely focused on the game world. Another form of immersion that is particularly central for games, as they are fundamentally based on interaction, is challenge-based immersion. This is the feeling of immersion that is at its most powerful when one is able to achieve a satisfying balance of challenges and abilities.

An alternative to this is the Player Involvement Model (Calleja, G. 2007) which attempts to break this down further by analysing immersion on the macro and micro level. Player Involvement Model constitutes six frames of involvement structured on two temporal phases: macro-involvement and micro-involvement.

The macro phase explores motivations to games that influence sustained engagement through the long-term (as opposed to momentary) aspects of each of the six frames. The micro phase of the model focuses on the moment by moment involvement of the game-playing instance. The six frames of involvement correspond to the groups of themes derived from analysis of the qualitative research conducted as part of the research for Calleja's player involvement model.

• Control and movement in the game environment (kinesthetic involvement)

• The exploration, navigation and learning of the game's spatial domain (spatial involvement)

• Players' interaction with other players in the game environment (shared involvement)

• Story elements written into a game or from player interaction (narrative involvement)

• The emotions generated during gameplay (affective involvement)

• The pursuit of goals and the making of choices in a game (ludic involvement)

These six frames will not apply with equal amounts to each and every game; some will clearly be more relevant to certain games than others. The frames and phases outlined in the model are meant to play a descriptive role. The aim here is to provide concepts that articulate aspects of digital game involvement.

Calleja also discusses the importance of distinguishing between the ergodic and non-ergodic media. In this case, involvement that requires non-trivial effort on the player to interact is considered to be ergodic involvement.

Given the essential difference between ergodic and non-ergodic media, it is crucial for a precise inquiry into the phenomenon of presence to make a distinction between simply imagining one is present in a scene and the considerably different phenomenon of having one's specific location and presence within a virtual world acknowledged by the system itself.

Measuring Player Immersion

This section provides examples of current techniques used to measure player immersion in games, and how the area of analysing the player experience could be improved upon.

A topic that is gathering a lot of interest in the games research community is how player behaviour in-game relates to the subjective experience of playing a game. However, there are some challenges towards this. One of the main challenges is the possible situation of inferring the player experience from behaviour (Drachen, A. 2012). Inferring player experience from behaviour alone can however be prone to errors, as it is not possible to verify whether conclusions drawn from behavioural analysis are correct unless some form of measure of the playing experience is used, e.g. a survey or interview questions.

This approach in games research, however, is challenging for new researchers because of the proliferation of questionnaires available. Nordin (2014) discussed the need for positioning the various questionnaires in relation to each other. They listed all the current available questionnaires to measure engagement whilst playing digital games, arguing that further investigation on these questionnaires is needed to produce better quality questionnaires and reduce confusion amongst player experience researchers.

Numerous questionnaires have been developed that can be used to evaluate the immersion of a gaming experience. To give a few examples, Brockmyer et al. (2009) proposed the Game Engagement Questionnaire (GEQ) based on previous work on absorption, flow, presence and immersion.

Qin et al. (2009) presented a questionnaire focused on studying the immersion in the narrative of game. Calvillo-Gámez et al. (2015) presented the Core Elements of the Gaming Experience Questionnaire (CEGEQ), which is based on a grounded theory approach. No single scale has been established as a norm (Nordin et al., 2014), which makes comparison between studies problematic.

The problem with IEQ and some other similar questionnaires, for example CEQEQ (Calvillo - Gámez et al., 2015), is that they are based on assumptions that the game contains graphics and/or that the subjects can use visual information. As an example, in the CEQEQ 6 out of 38 questions refer to visual aspects of the game.

The score can be computed by excluding questions, but it may affect the validity of a comparison if one group has 20% more questions than the other. In the IEQ (Jennet et al., 2008) there is only one question, out of 31, which assumes that the game contains graphical elements. This question is to what extend subjects appreciate the graphics and imagery.

Interestingly, the IEQ does not have a corresponding question related to the audio. This is a clear weakness of the IEQ – the importance of audio to the immersion of games is previously documented (Lipscomb, S.D. 2004). The conclusion from this is that it is not possible to use IEQ unchanged in the context of this research.

Immersion and Sound

This section will discuss the interplay between the concept of player immersion and sound design within games, and the relationship between the two, with a variety of examples to highlight this connection.

Immersion, is in part, enabled through a system of sonic perceptual realism that is technically enabled through the game engines sonification capabilities (Grimshaw, M. 2008). The images on screen can only be part of a virtual environment as they are a 2D representation of a 3-dimensional space. Sound though, exists and operates both in reality and in the virtual space. It has a real volume and dimensionality that is a 3D representation of the world of the game.

Sound is also illusory not just because it refers to a virtual resonating space (Grimshaw, M. 2007) but also because it can make use of caricature rather than authentic sound to represent a variety of elements within the game. Parker and Heerama, (2008) discuss the possibility of acousmatic sound for engendering an instinctive, primeval fear in the player and this is particularly useful in the FPS game where the player is in the position of being hunted.

FPS game sonification is predicated upon player presence and action. Most audification of audio samples occurs only in response to player action, or at the very least, player interaction with the game system.

For example, for many game engine-initiated sounds, the player may exercise control over the sonification by moving their character in relation to the sound source. Sonification provides a relational framework for the player to begin to contextualize themselves within the gamespace or in relation to the events and other characters. (Grimshaw, M. 2007)

It is also the case that audio beacons requiring the navigational listening mode provide a similar immersive potential especially where a game or level is being learnt and the player is constructing navigational mental maps. This is one of the reasons why game project is being developed specifically for this research.

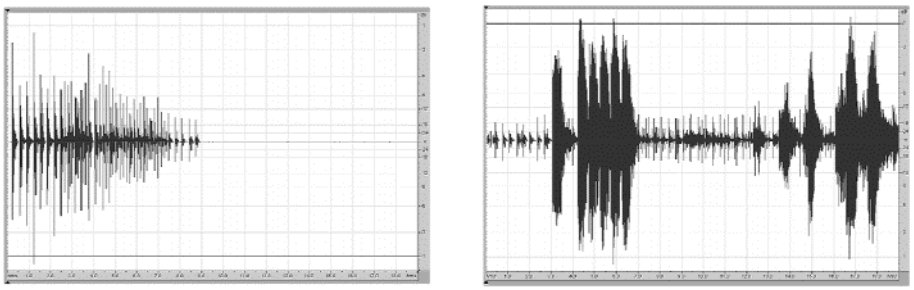

Figure 2- Sounds by an inactive FPS player and active FPS player in Urban Terror (Grimshaw, M. 2008)

McMahan's discussion of immersion in digital games describe these immersory cues as sureties; mundane cues that conform to player expectation. (McMahan, A. 2003) Her three categories of surprises (attractors, connectors and retainers) either provoke an action on the part of the player or are an aid to navigation and orientation. McMahan follows this with one of her three conditions for an immersive experience – "The user's actions must have a non-trivial impact upon the environment." This is demonstrated in the figure showing the difference in sound output from an inactive and active player in Urban Terror. The difference between the two soundscapes demonstrates that the intervention of the active player has a direct impact upon the acoustic ecology.

This acoustic ecology is particularly the case when the player is using headphones because they serve as an extension to the player's auditory system greatly attenuating (Grimshaw, M. 2008). In some cases this may mean entirely blocking out sounds external to the game world that could otherwise be a distraction. Ekman, I. (2013) also raises the discussion that if it is accepted that immersion or non-immersion are not purely qualities of modality – that sound does not automatically imply immersion – there must also be an option to choose whether sound is used in an immersive fashion. The question then becomes if non-immersive sound is simply bad sound, or are there aesthetic choices related to non-immersion that are not inferior, only different, from immersive design?

The recognition that immersion depends on blurring boundaries suggests one direction where to look for alternative aesthetic qualities; there is the case where boundaries are actively part of the design. For one, without clear differentiation, annotations and references become impossible. For example, Rowland, D. (2009) detailed how they opted for non-immersion for a pervasive sound experience for sound to make annotation and commentary about the environment.

In the case of sound, the heightened, focussed sound including over-clear dialogue can be considered realistic if it is viewed as a portrayal not of the scene, but of the experience of

listening to the scene. While the game environment usually contains a multitude of sounds, players only attend to a select few at a time. A person with normal hearing has no difficulty in following a single conversation in a room filled with people, the phenomenon so aptly named the 'cocktail-party' effect (Hawley, M. 2004).

The narrative realism of a sound is thus not in faithful reproduction of sound sources, nor of their environments. The apparent realism of a sound in the context of narrative is defined by how representative a sound is of a certain event. Sounds that are highly representative have good narrative fit, and a high narrative fit supports empathetic emotion (Ekman, L. 2008).

When sound is removed players experienced a loss of control and a sense of helplessness because an access point between the player and the game had disappeared (Jorgensen, K. 2008). Compared to visual perception, audio perception has the advantage that it does not require a listener to be oriented in a specific direction. This means that sound is useful in situations where the visual system is not available, for instance to provide information about events located out of line of sight.

Removing sound from a game decreases player ability to locate enemies and receive information about specific events.

The result is that the sense of spatiality is reduced, and consequently the players will have a lowered understanding of the specific situation. This relates to the term referred to as the acousmatic function, which refers to the situation where one can hear a sound but cannot see the source. (Stockburger, A. 2003)

An interesting effect related to the sense of presence is that in the case of Hitman Contracts (IO Interactive, 2004), one of the participants reported becoming more scared and even a little paranoid when the sound was removed. Since the participant could not receive any auditory information about what was happening out of the line of sight, he felt that dangers may be hiding in the shadows everywhere around him.

A recent study by Varghese, L. et Al (2017) set out to investigate the relationship between audio and visual stimuli. Players sit on the bow of a boat overlooking water. Occasionally fish swim past. Some of the fish—referred to in the experiment as the "good" fish—change size slowly as they go by. The "bad" fish change shape more quickly. Players score points by rapidly clicking one button whenever they spot a good fish and a different button whenever they spot a bad one.

In addition to this visual component, the game also had sound cues. Each fish was accompanied by a musical tone that fluctuated while it was on screen. Players had an easier time identifying the good and bad fish when the tones changed at a rate similar to their shape. When these two things were mismatched—say, a bad fish changing in size rapidly accompanied by a tone that was shifting more slowly—players struggled more to earn points.

The results showed that auditory information can drive the perception of visual temporal properties. Specifically, the study found more errors in identifying the visual modulation rate when visual and auditory inputs were mismatched, even though participants were instructed to ignore the sounds.

Players' performance was at its worst when there were no sound cues at all. This is significant to the current research because it highlights how the sound design of the game does not solely impact player immersion but also directly affects their performance, and later research into immersion will highlight the relationship between player performance, motivation to keep playing, and immersion within the game.

Infrasound refers to soundwaves with a frequency below 20 hertz (Hz), the lower limit of human hearing. Exposure to infrasound in humans appears to produce a range of effects including breathlessness, panic, anxiety, and even a sense of something paranormal (Tandy & Lawrence, 1998). Adding a 17 Hz tone to an orchestral performance increased "Unusual reports such a sense of coldness, anxiety and shivers down the spine" (Angliss, S. 2003).

Recently there has been interest in the use of infrasound within game design. Specifically, a research project that attempted to determine if infrasound could increase a player's emotional response to horror video games (Macdonald, H. et Al, 2017). The study involved having to develop a sound system that can produce infrasound. Commercial-off-the-shelf speakers cannot produce infrasound at noticeable volume. Even the speakers rated to 20 Hz that were tested fell off dramatically between 23 and 25 Hz. It is useful that the paper notes this during the instrumentation process because it enables future research to more accurately recreate any studies that require infrasound.

Macdonald, H. et Al, (2017) modified the 2D side-scrolling horror-puzzle game, Limbo (Playdead, 2010), because of its anxiety-inducing atmosphere and publicly available audio

files. They used the sound engine Wise to insert a 17 Hz tone such that, for each play through, each section has a 50% chance of the infrasonic tone occurring for the duration of that section.

The study recruited eight female and four male undergraduate students. Participant heart rate was measured using a Polar chest strap sensor. Heart rate is a common reflective indicator of stress and anxiety (Dobkin & Pihl, 1992). Average play time was 1.5 hours.

Unfortunately, the collected data is currently in progress of being analysed and according to the paper the findings will not be published until a later date. However, previous research into Infrasound has found that is has a negative effect on participant performance and emotional stability. In another experiment, 20 men exposed to infrasound showed significant changes in blood pressure (Danielson, A. 1985). Similar results with pilots showed that long term exposure to infrasound, decreased alertness and altered perception of time (Lidstrom, I. 1978).

Sound Design in Horror Games

Expanding upon the previous chapter regarding sound and immersion, this section will focus on a specific genre of game to explore the different techniques used to provide immersive experiences to the player through the modality of sound.

Horror games highlight how the medium is able to convey immersive sound design effectively to the audience. An example of this can be found in Bioshock (2K Games, 2008) a first-person shooter game set in an underwater city with elements of role-playing and survival horror. The ambience in BioShock lingers between the diegetic and the non-diegetic: a typical engine hum is for example audible, but underneath there are sporadic, high-pitched sounds. (This distinction between the diegetic and non-diegetic sound (and transdiegetic) will be discussed further in the literature review).

The latter does not appear to have any connection to the diegetic environment presented in Bioshock, and likewise while in Neptune's Bounty (an area within Bioshock) the player will hear the creaks of metal and running water but might also notice a note played in crescendo. These two examples are arguably not background music as they do not have a constant presence and only constitute a limited tune.

It might however be argued that they are examples of Jørgensen's point that ambience should not be taken literally: Instead ambience frames the general atmosphere in the player's current area (Jørgensen, K. 2007). A crescendo is traditionally used in horror

movies to instil anticipatory fear, an effect that BioShock mimics in a slightly different form. In BioShock the crescendos are activated after a time lapse and not on basis of narrative structures. One could argue that this leads to an increase in tension, as most players will be familiar with the culturally implied meaning of such a crescendo (a leitmotif for shocks), and thus they will be prepared for encounters, which may or may not take place.

The ambience in Silent Hill (Konami, 1999) does not adapt to fights as seen in other games (Whalen 2004), and is usually deep bass or a slowly oscillating pitch. Similar to BioShock the ambience lacks tonality and a clear melody, and therefore is likely to be perceived as part of the diegetic world. An analytical player might identify the ambience as non-diegetic, but the atonality breaks the usual expectations to background music. Arguably atonal ambience can be experienced as closer to the diegesis as it is less cohesive, thereby provoking uncertainty about the sound's non-diegetic nature. The ambience in Silent Hill thus assumes the role of sensory filler with uncertainty as an effect.

Silent Hill utilizes a variety of sounds that afford a threat warning, such as the radio communication between enemy soldiers, which can be heard far away and is the primary source for identifying their presence before visual confirmation can be made. Other sounds afford a similar warning, but lack the consistency of the radio signals, such as the static caught in the player's earpiece.

The static is usually an indicator for approaching paranormal events, but is sometimes played without any following consequences. This pseudo-causality is designed to put the player on edge and make him carefully considering his moves even though no threat is imminent. The misuse of the static reduces the player's faith in it as a reliable tool, but accentuates that something might happen.

More recently, Hellblade: Senua's Sacrifice (Ninja Theory, 2017) adventure, protagonist Senua suffers from psychosis causing her to hear voices, and the game uses binaural audio to make you feel like you're hearing them too. Binaural recording uses two microphones, adding a 3D effect that goes deeper than surround sound by tricking your brain and giving you the sensation that what you're hearing is in the room with you. If you wear headphones for Hellblade, you'll hear voices seemingly coming from all around you, and the effect is chilling.

The Dead Space series (Visceral Games, 2013) features the innovative use of "fear emitters." These allowed the audio team to build suspense even if the player didn't follow

an expected route or interact with the environment in a specific way. So for example, instead of having a terrifying sound grow louder as the player walks a long hallway, they attached fear emitters to specific objects or enemies, causing the sound to build as the player gets closer to an object or until they come face-to-face with a creature. The team used fear emitters in conjunction with the soundtrack by creating four layered stereo streams, which are mixed in real time according to how much fear is being emitted in-game. The more fear emitters going off, the louder and more intense the music becomes.

Augmented reality and indoor location-based games are also able to immerse the player in a horror-based virtual environment through the use of sound design. Park, S. et Al (2014) developed an indoor game that uses indirect ambient cues projected in a handheld instrument. The room illumination changes and the three-dimensional localized sounds are used to identify the sounds and the 'escape zone'. The Escape! Game was designed to only allow one player, and so this project aims to expand upon the study of sound design and immersion using multiple players.

Collaborative Horror experiences

Whilst little research has been done on how playing local cooperative horror games can determine player immersion, this section briefly examines how the collectivity of a film audience can influence the viewing experience, and if there is potential for similar results to occur in game design.

Films studies provides an insight as to the reasoning of the general audience decision to view horror and thriller films as a collective experience to defuse the immersive tension generated by the film. This is noteworthy because from a game design perspective it is normally intended for the player immersion to increase when in a collaborative environment, as discussed later in this literature review regarding analysing levels of player cooperation.

The more one might expect the cinematic situation to be a shared activity, the more significant the normative agreement, the stronger the obligation to act accordingly and the bigger the entitlement to be angry about its disruption (Hanich, J. 2014). The differences between what viewers are entitled to expect are thus dependant on the strength of the expectation of a we-intention.

Most of the time one does not actively think about the rest of the audience. Consciousness is directed towards the film. It is especially helpful to consider the collectivity inside the

cinema as such a tacit background. Obviously, collectivity is not necessary for the film experience, but in the cinema the collectivity of the audience is taken for granted as an invariant component. The phenomenology of the background of the other viewers becomes foregrounded by its non-presence. The room not only looks empty, but feels empty. (Hanich, J. 2014)

Tying this back to the collaborative film experience, when a person goes to the cinema with someone who shares a normative agreement in the shared activity, there is a higher chance of their backgrounded presence rising to the fore, and distracting from the film experience (Hanich, J. 2014). In the case of horror films, some viewers may elect to perform this intentionally to ground themselves to the presence of the safe environment as the imagery presented on screen is less demanding due to the familiarity of the collectivity.

Özüpek, N. et al (2007) has also explored audience motivations for watching horror films and the appeal of fear in the viewing experience, which has some interesting relatability to this research project. As the study above notes, 79.1% of participants answered that they watch horror films in a shared environment. When asked why, the majority of responses related to the preference of watching a horror film in a 'secure' atmosphere. This again highlights how previous collaborative horror experiences are used to decrease sense of tension and immersion, and it will be interesting to examine whether the research project can invert this so that the cooperative experience retains immersion.

Another interesting insight in the study is that there was a slight increase from respondents regarding how they were frightened of the sound effects in comparison to the visuals of the film. This supports the argument that in regard to player immersion, the sound design of the game is crucial to the experience.

Audio Games

This section will provide several examples of games that focus on auditory information to provide gameplay to the player, and if any design methods could be incorporated into this research.

AudioDoom, based on the original Doom game, is arranged as a spatial sonic configuration of small environments (Sanchez, J. 1999). Research into these types of spatially rendered audio-based games has demonstrated that both sighted and visually impaired players are able to conceptualize a physical game space in the absence of visuals. Even without visuals,

audio-based games create a mental space the players mind that the player can navigate through their mental mapping of the game environment.

Papa Sangre (Somethin Else, 2013) is a mobile audio game that relies on binaural audio technology to create a spatial environment in the player's headphones. Without using their eyes, players navigate through areas by tapping on feet on-screen. The games story is told only through sound; each area has its own sonic identity, and different monsters are represented through sound effects. The lack of images is one element that makes it more frightening. It is moving through the space that makes it scary.

Figure 3- The User Interface in Papa Sangre (Somethin Else, 2013) indicates to the player the need to wear headphones to play the game.

There have also been studies focusing on spatial audio and reverberation in an augmented reality game. Paterson, N. et Al, (2011) noted that the role of audio as navigation can be supported by providing contextual navigational instructions, such as triggering sounds near intended locations that increase in volume and complexity as the player moves closer to that location.

This navigational strategy also notes that constant background sound between significant locations is avoided so as not to overload the user experience and take away from the immersion.

The study notes that in terms of methods of evaluating sound design, objective measures such as physiological changes are unreliable indicators of emotion response (Paterson, N. et Al, 2011). Therefore, for a phenomenological experience, subjective reports in the form of questionnaires were used for the assessments. It also consisted of a set of statements of which 9 out 22 were specifically related to audio with players responding using a Likert scale.

The academic literature provided by Crispien et Al (1996) discusses a more general spatial auditory environment, with some research into speech recognition and movement

detection that is difficult to relate to this current project. However, the literature is still relevant by contextualizing some of the issues that development of the game may face when considering non-visual interaction. The research discusses audio-processing techniques as well as audio presentations of text which would be appropriate for any UI design that may be included in-game.

The paper also identifies some of the problems within audio-based interaction that would be considered when attempting to implement, such as a lack of localization precision that can be created due to perceptual distortions that can be caused by the use of non-individual HRTFs. (Crispien et Al, 1996) HRTF stands for Head-Related Transfer Function, and the basic assumption in the creation of a virtual auditory space is that if the acoustic waveforms presented at a listener's eardrums are the same under headphones as in free field, then the listeners experience should also be the same. Typically, sounds generated from headphones appear to originate from within the head. In the virtual auditory space, the headphones should be able to 'externalize' the sound.

By analysing this issue, it would be a natural design consideration to avoid overloading the player's auditory perceptive capabilities to ensure an understanding of the environment and support the accessibility of sound-based gameplay.

Audio Games for the visually impaired

Expanding upon the previous section, this section will examine games that have been developed specifically for the visually impaired. Though this research is not focused on accessibility or vision therapy, there are several design choices that would be aligned with this area of study.

Research by (Bălan, O. 2014) notes that the use of the auditory sense as a mechanism for navigation within a game is effective, but requires sufficient training for more complex 3D environments to be represented proficiently.

This inclines the implementation of this project to assume a more simplistic approach when considering level design so that players require less challenge in decoding audio information and converting into a spatial mental representation. As Yuan, B. (2010) suggests, the number of people who play games and suffer from visual impairments is continuously increasing due to the accessibility of the market, so there is a strong need for efficient sensory substitution devices, which can support a rich mental spatial depiction of the environment.

The research included experimentation of ludic-orientated, motivational training approaches to achieve straightforward immersion and concentration of the environment. This is relevant to the design of the project when considering how feedback is delivered to the players when achieving certain objectives within the game so that they are ensured behavioural gains in the sound-directed spatial orientation.

Friberg, J. (2004) also discusses the challenge of balancing functionality and aesthetics, by attempting to design specialized soundtracks as opposed to separate background music and game effect sounds. The issue that arose in the study is in relation to the accessibility issues in preventing players from adjusting specific sound levels in the audio mixer of the game.

It should be stressed that this project aims to in part make a more inclusive method of measuring immersion, but it is not intended as a therapeutic method for improving vision, nor is intended to explore specifically audio-based immersion for the visually impaired.

Developments of HRTF Audio

This section will briefly discuss some of the technicality of implementing sound within the game space, and some of the techniques used to provide audio that could be considered immersive.

In order to achieve realistic pantophonic (i.e. full-sphere) 3D sound, an absolute minimum of six speakers around and above the player is required. However, because of the design of the game demands that only one player is able to hear the auditory information, it will be necessary for headphones to be used.

Adding HRTF filtering already immensely improves the sensation of direction over a conventional panning. Direct HRTF is somewhat limited though as it only is concerned with the direct path of audio and not how it is transmitted in space (Tsingos, N. 2004). Sound occlusion is a very hard problem to solve in terms of computation power. Therefore, calculating the way sound actually moves around (as waves) in a room is not efficient. For the same reason there are many approaches towards spatialization tackling different problems to various extents.

Finally, research has shown that the more familiar a user is with a type of sound, the more real it will feel, and the more easily they will be able to locate it in their environment. (Gygi, B. 2001). A human voice, for example, is a very common type of sound, and users will locate it just as quickly as a real person in the room talking to them. This also relates to the

phenomenon to focus auditory attention on a particular stimulus whilst filtering out a range of other stimuli (Getzmann, S. 2016). If the player is used to a sound coming from a particular direction, their attention will be guided in that direction regardless of spatial cues. This will be relevant for the game design and implementation.

Defining Transdiegetic Sound

This section will discuss the semantics of listening, the distinction between diegetic and non-diegetic sound, and provide the concept of transdiegetic sound which is central to this research.

Before beginning to design a sound-based game, it is important to first recognize and distinguish the semantic differences between listening to and interacting with sound. When one is listening to audio, they are external to the action taking place; an auditory observer. Film theorist Michel Chion categorizes three basic listening modes; casual, semantic and reduced. These modes are not mutually exclusive, and players may be listening in several ways a time during a game. (Chion, M. 2012)

Musicologist David Huron expands this when regarding interactive media that imply action and participation on the part of the listener. Signal listening for example is 'listening in readiness', where the player is listening for a particular cue or auditory sign post (Huron, D. 2012). One could possibly also extend signal listening beyond music by listening to sound effects for navigational information about direction and proximity.

Regarding the definition of interactivity, it is helpful to consider interaction on a non-hierarchical spectrum. Some of these interactions take place directly between a player and the game, and some are external to the game play (metagame interactions) (Huron, D. 2012). There are also interactions that take place between modalities (audio, visual, and haptic) the player in this case is involved in the perceptual process of interpreting these interactions, both as spectator and interactor.

Sound in interactive media such as games is multimodal – that is it involves the interaction of more than one sensory modality and unlike noninteractive sound, interactive sound requires more than one modality. Schizophonia suggests that when one hears a sound separated from its source, one might experience some technological anxiety (Feld, S. 1995). Consequently, it would be interesting to explore the ramifications of having these modalities separated between two players and explore how communication between the two affects the sensory associations.

The idea of diegetic and non-diegetic sound has been used for many years in the medium of film and theatre. Sound is called diegetic when its source is visible or implied in the world of the film, whereas sound is said to be nondiegetic when its source is not present or implied in the narrative universe (Gorbman, C. 1980).

For example, the car radio within a movie in which the characters can hear would be considered diegetic, whilst the instrumental musical score of the film would be considered non-diegetic.

The trans-diegetic effect of audio examined by Kristine Jørgensen (2007) is a lapse of the traditional barrier between diegesis and non-diegesis as explained by Bordwell &Thompson (2004). The film viewer's ability to understand this divide comes from repeated exposure to the language of films, where breakdowns of the barrier are rare and usually act as comic relief (such as the big band in Mel Brooks' Blazing Saddles that is thought to be non-diegetic, but then happens to be located out in the desert).

Jørgensen argues however that due to the interactivity of video games, sound can pass the barrier and in effect become transdiegetic. Units in Warcraft III (Blizzard, 2002) for example speak directly to the player as a way of conveying information, i.e. they speak from within the diegesis to the outside, while music in the game can function as a theme for certain events, allowing the player to anticipate future events (Jørgensen, K. 2008). Trans-diegetic sound does not dissolve the barrier though: It merely causes a short transgression that still keeps the division between diegesis and non-diegesis intact.

The trans-diegetic effect therefore typically transfers information from the game to the player, according to Jørgensen in two different versions: Either as a reactive sound affirming player input or as a proactive sound informing the player of an altered game state (Jørgensen, K. 2011).

Jørgensen's argument relies upon the fact that players can interpret the soundscape of a given game as triggered by specific events, i.e. not being completely random. The ability to interpret can partly be learned through genre conventions and by keeping a consistency of sound.

Transdiegetic sounds in computer games do not originate from diegetic space, but they do in some respect concern specific situations within the diegesis. Game sound with diegetic origin may still be regarded as diegetic even though it is posited within the diegesis in an unnatural manner (Jørgensen, K. 2011).

Game designers typically conceptually separate the soundtrack from the diegetic game sounds both in the way the software handles them and in the separate volume controls available to the player in the set-up menu.

Many FPS players turn the musical soundtrack off completely; turning down the soundtrack enables the player to attend more closely to subtle diegetic sounds presaging, for example, an enemy approaching – very important in the 'hunter and the hunted' scenario that characterizes FPS games (M. Grimshaw, 2007).

However, categorically defining the soundtrack as nondiegetic risks the supposition that music has no effect upon the player's actions and engagement with the game. Some FPS games deliberately use music to cue certain game events, and in deriving from the internal logic of the game-play, such as musical soundtracks therefore have a diegetic element to them. In many horror games the soundscape affords less to the player, as sounds are difficult to tell apart. The player's difficulty in dividing sounds into non-diegetic and diegetic can be described as an actual collapse of the diegetic barrier.

This effect goes beyond Jørgensen's theory of the transdiegetic since the players are unable to prepare for future action based on non-diegetic information. Instead they may act because they do not know if sound is diegetic or not. The atonal ambience reduces the perceived field of non-diegetic sound, and all sounds may be suspected to belong to the diegesis.

The trans-diegetic sound can be also broken down further into external transdiegetic and internal transdiegetic sounds, depending on the layer of communication. Grimshaw, M. (2007) provides this distinction by giving an example for each. In Warcraft III (Blizzard, 2002), the dialogue "Our base is under attack!" would be an instance of external transdiegetic because it provides information relevant to player action, but it is not produced by anyone within the game world.

When the avatar in Diablo 2 (Blizzard, 1998) claims "I'm overburdened", however, it can be considered internal transdiegetic because the avatar as a character exists within the game world but is communicating to the player situation in an external position.

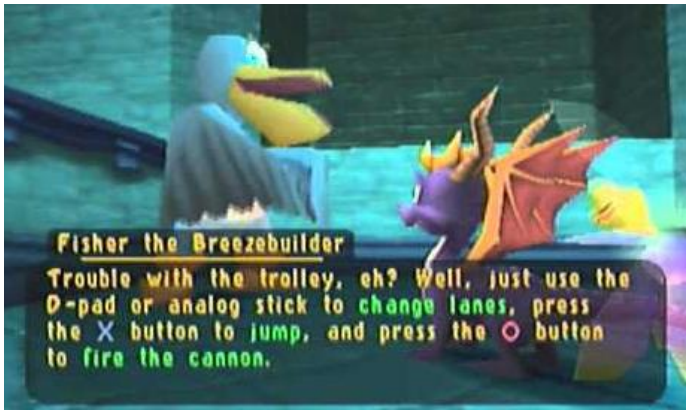

Figure 4 - Tutorials in games such as Spyro 2: Gateway to Glimmer, can highlight internal transdiegetic information because the characters exist in the game space but are communicating to an external player

The strength of the trans-diegetic effect as a concept is that it emphasises the functional role of sound in relation to player action within the game world. This research therefore could specify that it is examining internal transdiegetic sound, but in a reversed position as the Diablo 2 example provides.

The game being developed for the purpose of this research uses player voice input from an external position of the game space to provide information to the game space. Whilst there is a body of research into voice input in games and transdiegetic sound, little has been done to examine the overlap between the two.

Voice Input in Games

This section will examine research that explores voice input and voice interaction in games, techniques used and design choices that may be useful for this work.

A related but distinct topic when discussing sound interaction in games is the concept of voice input as a game mechanic when designing games. This is also distinguishable from voice communication with other players within the game space (A topic that will be discussed later in the literature review) but instead how the player's pitch and volume may affect certain values or variables within the programming of the game.

Understanding this interaction is a crucial component to this research as it is a demonstration of both transdiegtic sound (sound that is from outside the gamespace but is now affecting or relating to the game environment) but also an example of ergodic interaction in the way that the game acknowledges the players specific presence.

A majority of research involving voice input in games focuses non-verbal voice input, which works well for the study because the design of the research game is focused solely on the volume that the players communicate and is not attempting to observe for any key phrases.

Hughes, J. (2001) was fundamental in researching the use of non-verbal features in voice for direct control of interactive applications. The aim was to achieve more direct, immediate interaction like using a button or joystick by using lower-level features of voice such as pitch and volume.

Several prototype interaction techniques were based on this idea, such as "control by continuous voice", "rate-based parameter control by pitch," and "discrete parameter control by tonguing." Having implemented several prototype systems, Hughes suggested that voice-as-sound techniques can enhance traditional voice recognition approach.

The disadvantage of Hughes approach as he acknowledges in the paper is when implementing voice input interaction for complete control of an application like a game is that it requires an unnatural way of using the voice which several players were not comfortable with.

The game is not just passively observing for a single value like a specific change in volume, but instead the player is having to use a variety of vocal techniques to manipulate the game avatar in a specific way to move them in certain directions. As a result, continuously making vocal sound tires the throat and can also be difficult to initially learn.

This was initially surprising because a large portion of voice input research focuses on how the interaction improves the level of accessibility to players. (Harada, S. 2011) built a prototype system called the Voice Game Controller that augments traditional speech-based input methods with non-speech voice input methods to make computer games originally designed for the keyboard and mouse playable using voice only.

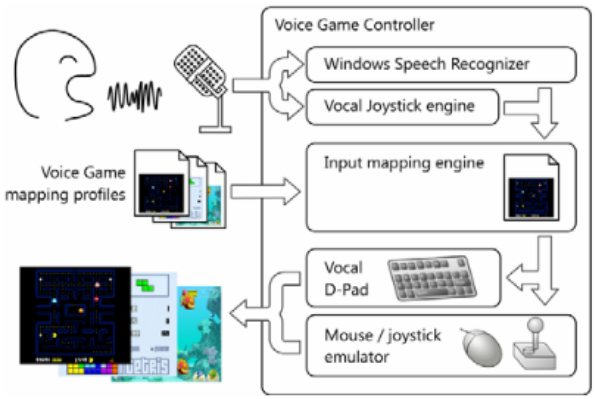

Figure 5- Voice Game Controller architecture (Harada, S. 2011) User's utterances are processed by the Vocal Joystick engine, and the corresponding key-board/mouse/joystick signals are emulated based on the active Voice Game mapping profile.

The evaluation of the prototype indicated that the Voice Game Controller greatly expanded the scope of computer games that can be played hands-free using just voice, to include games that were difficult or impractical to play using previous speech-based methods. The results from the study showed that non-speech voice input can offer significantly faster input compared to a speech-based input method by as much as 50%. The study also reported that none of the participants raised vocal fatigue as an issue during the study. Thus, there may be something to be said by how the design of the game affects the level of input and voice manipulation required to play the game.

Again because of the differences in design, this research will not be as concerned with the delay in feedback for the player. And although the study focuses on the continuous detection of pitch rather than volume, it is useful to note from the study the extraneous variables that may affect the voice input.

Carter, M. (2015) also explored Player Identity Dissonance and Voice Interaction in Games and makes the argument that notions of player and avatar identity are inextricable from the successful implementation of voice interaction in games. They also argue that the successful integration of voice interaction in digital games is distinct from voice interaction in other contexts, as in games it demands consideration of the identity of the voice; that is, whose voice it is that is being recognized, and how that voice is embodied.

The research was performed by examining discussions of voice interactions in game reviews, articles, let's play videos and exploring how the themes that arose in these were highlighted in case study games. Tomb Raider: Definitive Edition (Crystal Dynamics, 2013)

utilizes voice recognition to permit simple voice commands. These allow the player to bring up menu items (e.g. by saying “show map”) and pause/resume the game.

(Carter, M. 2015) found that users raised issues around the voice interaction with regard to performance and discomfort. Performance issues included reports that the speech recognition was not reliable, and more generally, complaints that it was “faster just pressing a button”. It was frequently seen that speed, and subsequently improved performance, were regarded as metrics by which to evaluate the voice interface, due to its effect on the player’s sense of physical mastery.

Issues of discomfort with the voice interface were raised in both online discussions and reviews. Players frequently noted that repeatedly yelling “shotgun” at their television was “uncomfortable” and “embarrassing”, and that it restricted the use of the interface to when other people were not present to be bothered by the noise.

In contrast, In the Xbox One version of the game Splinter Cell: Blacklist (Ubisoft Toronto, 2013), the user can yell “Hey you!” to the Kinect sensor, and game avatar calls out “Hey you!” in the game, making a virtual sound which the enemy guards will investigate. According to the study, in comparison to other examples of voice interaction, players liked that they were doing what their character would actually do, rather than something “unnatural” that they would not normally say out loud.

Ryse: Son of Rome (Crytek, 2013) is a third-person combat game for Xbox One in which the user plays a Roman centurion, occasionally commanding other troops in battle. Ryse features voice commands such as “fire volley” and “charge” that are relevant to events in the game’s linear story, and the opportunity to use them is triggered by in-game events.

Overwhelmingly, players spoke positively about the voice commands, with the feature commonly being referred to as “immersive”, and negative comments limited to the infrequent opportunities to use them. In the context of the game’s ancient Roman setting, Carter, M. (2015) identified numerous instances where players “Put on the roman soldier epic voice for it and everything” reflecting the virtually embodied “real” voice noted in the example of Splinter Cell: Blacklist (Ubisoft Toronto, 2013).

Carter et al. (2012) distinguishes between four types of identities present in a game play situation: the user (the “real” human who plays); the player (a social identity); the character (an identity within a game’s imaginary world); and the avatar (the character’s virtual depiction). This framework does not suggest that players necessarily identify with

their characters, but instead establishes them as separate identity constructs which may overlap and inform each other in a game-play situation.

In the example of Splinter Cell: Blacklist (Ubisoft Toronto, 2013), voice was well received because of a voice-based resonance between the user's player identity and the character identity of Sam Fischer; the user saying "hey you" in the real world meant that their character said "hey you" in the virtual world, with the expected effect. Virtually embodying the player's real voice increases (at least the perception of) the overlap between the player and character identities. Players' comments indicated that this could be contributing to an increase in their sense of flow and immersion.

Perhaps the most extreme example of this overlap is found in karaoke games such as SingStar (London Studio, 2004), in which the character in the game space is almost completely defined by the singing voice of the player. This argument supports the research objective of this work, as the design of the game is that wherein the players voice directly affects interaction within the game space from a first-person perspective.

Alien: Isolation (Creative Assembly, 2014) is a first-person survival horror game which features an optional noise detection setting that can be enabled before starting the game. The PS4 and Xbox One versions of the game both offer options to use the PlayStation Camera and Kinect to act as an input which enemy AI will respond to. This provides interesting gameplay moments because players may react audibly to moments in the game due to fear or excitement, when they should be attempting to be silent to prevent the enemy AI from determining their position. Alternatively, players may shout when in one area to lure or distract an enemy, and then attempt to flank and manoeuvre around them to reach a certain destination.

This level of vocal control creates a new modality of interaction with the game, and highlights a possible design pattern that can be applied in game design. Alien: Isolation would provide a key influence when approaching the design and implementation of this research game, because of the mechanic in which enemy AI responds to player noise input.

Alien: Isolation is also used as an example of AI as Villian (Treanor, M. et Al, 2015). The concept is an AI-based game design pattern in which it requires players to complete a task or overcome an AI opponent where the AI is aiming to create an experience (e.g., tension or excitement) rather than defeat the player. The opposing alien within the game rather than just being a character in the game world, is an attempting to create an intentional

experience for the player. In the game, the enemy alien spends the game hunting the player and displaying behaviours of seeking the players location and responding to their in-game actions. By having the AI also respond to out of game actions by responding to player noise input, the enemy alien may now appear more challenging to overcome, which can may increase the tension and immersion felt by the player, which being a survival horror game is presumably a desired experience intentionally designed by the developers.

Speech-based Player Communication

The section will discuss examples of multiplayer communication, with a focus on voice chat and what design methods could be beneficial.

There are studies that suggest that text-based communication does not have the same sociability that voice communication provides, nor does it provide speedy communication during in-game challenges (Wadley, et al., 2005). More recently, voice communication has been built directly into games; for example, in the Xbox LIVE online multiplayer platform.

In early online games, voice chat was sought frequently in competitive team-based first - person shooter games to support fast-paced combat. Recently some games, such as DayZ (Bohemia Interactive, 2013) have made use of the voice communication as a game mechanic, through an in-game proximity system that only allows nearby players in the game world to communicate. Voice has also been used as a method for control in single player games. Previous work has broadly explored player motives to engage in voice communication. Beyond using it to gain competitive advantage, some players use online gaming not just to connect with their teammates and opponents, but also as a way of staying in touch with friends, and research suggests that gaming communities may form for both social and cooperative reasons (Grimshaw, M. 2010).

In a multi-player game, each player operates on and within their own private soundscape. As in a real-world acoustic environment, there is a range of hearing (dictated by the game engine) beyond which the sounds forming other players' soundscapes are not heard. As soon as a player moves into the vicinity of another, their soundscapes begin to mingle and, in addition to their own diegetic sounds, each player starts to hear the other player's diegetic sounds (Grimshaw, M. 2008).

Gibbs, et al. (2006) had a study regarding voice communication in two game types, one with proximity communication and with push to talk. Players were quick to express how they felt overwhelmed by the amount of verbal information being sent. Part of noise was

grouped into speech that was not intended to be heard, such as collocated conversations. Gibbs fails to mention how many participants were in this party chat at any one point, but it is safe to assume it is more than just two players, so this project should not suffer the same auditory congestion.

Wadley, et al. (2007) found that in large groups of players using voice communication, it can be immersion breaking for players to have to wait for their turn to talk. With any communication study in game design, it is important to acknowledge whether or not the players have a previous familiarity with each-other or not, as a majority of players are more comfortable communicating with people they know than with strangers. Some research has investigated icebreaker sessions for players who are not familiar before starting the game, to see how their levels of cooperation and communication are affected (Hicks, K. 2017). Participants stated that they were more inclined to communicate openly with other players after participating in the icebreaking tasks. Additionally, Hicks suggested that icebreakers enabled players to communicate more efficiently.

When developing a research prototype that features cooperative play, it is important to also recognise how the familiarity of the other player affects levels of immersion and cooperation. To some extent users select communication media dependant on their understanding of the context. For example, people choose text over voice when eavesdropping is a concern, or when they desire more control over self-presentation (Carlson et Al, 2004).

Cues about state conveyed by voice introduced problems such as being reluctant to communicate with strangers, and increasing vulnerability to abuse (Wadley, G. 2005). The acceptability of voice in online games relies on a delicate balance between the benefits of team coordination and the problems of controlling social presence.

There was controversy in 2007 when the developers of Second Life (Linden Lab, 2003), an online social world game, introduced a voice channel. Many felt that voice would break the anonymity they valued and diminished the atmosphere of the game space. Informants who used Second Life for telecommuting, education and drama highly valued voice, praising the ability of voice to convey more richness and subtlety of meaning.

Studies within Day Z (Bohemia Interactive, 2013) have shown the way team-independent voice communication enables a unique style of player interaction that may be collaborative

or treacherous, resulting in a mutually beneficial trade or possibilities to deceive and betray.

Golub, A. (2010) also critiques the notion that people become immersed in virtual worlds because of the aesthetics of the simulation. Golub based his argument on two pieces of evidence. One was that people could be “immersed” in text-based multi-user-dungeon games that have no visual fidelity at all. The other was that players of beautifully rendered MMORPGs (Massive Multiplayer Online Role-Playing Games), in order to gain an advantage in the game, are willing to use mods that replace the 3D scene with numbers and charts that more clearly represent the underlying game state.

Figure 6-World of Warcraft mods like AddOn provides tables and graphs showing the combat distribution of the party, but are not intended UI elements of the game.

Information sharing does not automatically translate to improved clarity, and communication, especially unnecessary communication, leads to a rise in communication overhead (Toups, Z. 2016). Communication overhead is the cost of communicating, both the sender and recipient, in terms of attention, cognition, time and bandwidth. Consequently, efficient teams decrease communication overhead when they implicitly coordinate by anticipating a teammates needs.

Prior research in the field of deictic communication indicated that speech is less useful for describing locations and objects which are accessible to the user with other tools such as pointers and gestures. Eklund & Ask (2013) found that goal-driven gameplay has the possibility to hurt sociability in raids in World of Warcraft (Blizzard, 2004). It does not matter how friendly the player is if they cannot help the team carry out the task. This problem is magnified if players are using voice communication as it opens up an instantaneous channel for them to feedback this performance review.

Cooperation in multiplayer games

This section will briefly discuss previous research regarding design in multiplayer games that encourage cooperation between players.

The degree to which online games satisfy motivational needs is one of the major predictors of presence. Presence is associated with how a game play can satisfy psychological needs (Ryan et al., 2006). Daggubati, L. (2016) produced a study stating that cooperative gameplay induces a greater sense of immersion than non-cooperative gameplay due to the sense of relatedness, something self-determination theory deems as a psychological need that increases player motivation (Przybylski, A. 2006).

However, the study had participants playing with a game engine AI rather than another human player, so this research looks to see how the voice communication between two participants affects presence.

In terms of understanding and evaluating cooperative games, it is useful to investigate cooperative patterns or frameworks to critique them. El-Nasr, M. et Al, (2010) proposed the Cooperative Performance Metrics (CPM) model, which presents a set of cooperative patterns identified based on analysis of fourteen cooperative games

Toups, Z. (2014) has also developed a framework for cooperative communication game mechanics from a Grounded Theory approach. The framework provides six examples of cooperative communication mechanic types. Environment-modifying mechanics are used to alter the game environment to make it informative for other players. Automated communication mechanics simplify the communicator's job in intense gameplay, so that they can quickly supply complex game-specific information to teammates.

Immersive mechanics enhance the game experience by deepening the player's involvement in the games narrative or world. Expressive mechanics support players in supplying information about their own state during gameplay. Players create their own meaning through emergent mechanics, adopting their own meanings for game actions that were not primarily designed for communication. Finally, attention-focusing game mechanics allow players to point out components of the game environment to others, support a call to action or providing information.

Asymmetrical Gameplay

This section will provide an overview for the design pattern of asymmetrical gameplay within multiplayer games. Several examples will be provided, and we will examine how these mechanics could be appropriate for the research game.

When researching literature regarding methods used to analyse levels of cooperation on multiplayer games, it became apparent the variety of substyles that are used to facilitate cooperative play. Rocha K, et al. (2008) described several design patterns when analysing cooperative games that could be used as guidelines to encourage this type of cooperative play. Some of these, such as shared goals, can be a simple design pattern that force players to work together, such as a Capture the Flag mode in games like Team Fortress 2 (Valve, 2007) or Halo 3 (Bungie, 2007), in which the success of a team depends on whether the team can accomplish a certain goal.

Other design patterns however, such as synergies between abilities, introduce the concept of asymmetrical gameplay. An example of this can be found in LittleBigPlanet 3 (Media Molecule, 2014) in which one player may be able to double jump to reach a chest to knock down, and another player may be using a character that has extra strength to smash the item and release the item inside.

Figure 7- Keep Talking and Nobody Explodes (Steel Crate Games, 2015)

A good case study can be found in the game Keep talking and Nobody Explodes (Steel crate games, 2015) is a group party game, in which one person is in VR trying to defuse a bomb while the others look at a manual and try to give them instructions to defuse it. The player in VR must describe the bomb they see to the players outside VR who must find that description in a manual full of text. One of the criticisms of the game is that the instructors lose a sense of accomplishment as they have no feedback apart from the VR player describing the results page (Metacritic, 2017). This is important to consider as the game project has a similar design in terms of providing asymmetrical information to the players.

To contrast the variations that can occur within asymmetrical gameplay, the game HackTag (Piece of Cake Studios, 2017) is a two-player stealth game in which one player is an agent sneaking into buildings and the other is a hacker accessing the buildings systems, each supporting the other. Unlike Keep Talking and Nobody Explodes, HackTag provides both players with the same camera angle, but there is still information that is restricted to each individual and consequently this asymmetrical design still encourages player communication and coordination.

When designing this research project, it is not enough to simply consider the mechanical differences between players and simply hope they will engage in an ideal manner. Though the Torchless game highlights a design with conflicting interests between players, it still shows the affect giving players narrative motivation for their actions has on their communication. Research has shown that contextualizing the game for both players and making them understand the reasoning for their relationship with the other player helps not just with immersion, but their ability to communicate and coordinate effectively.

Hidden Profiles

This chapter will briefly discuss the concept of hidden profiles – a paradigm wherein parts of a problem to a situation are presented separately to individuals within a group, no group member can detect this best solution on the basis of her or his individual information prior to discussion; it can only be found by pooling the unshared information during group discussion. This highlights how asymmetrical information within an asymmetrical game can be used to encourage communication.

The hidden profile concept has been used in the study of psychology since 1985 (Stasser and Titus, 1985). The idea proposes a group problem-solving task whose solution can only be obtained when group members effectively pool their individual information about alternatives. A hidden profile is said to exist when the group collectively has more information supporting one alternative over others, but the superiority of this alternative is obscured from individual members unless information is shared. (Stasser and Titus, 2005)

One issue with hidden profiles is the time dedicated to discussion. Shared and unshared information are different in the amount time each is debated in group discussion. In other words, shared information is discussed far more often than unshared information. (Mesmer-Magnus and DeChurch,. 2009). This problem should be avoided when designing the game used for this research, because very little of the shared information players have

would hypothetically be discussed – the shared information the players receive at the start of the game is related to the mechanics of the game itself, which do not change.

Another complication to consider when integrating a game design pattern relating to the hidden profile paradigm is that when in a group setting, it has been shown that the unbalanced time dedication to shared information may be due to the uncomfortable nature of sharing novel, unique information. (Zuckerman, C. 1999) Discussing shared information can help to enhance other's evaluation of a person, while unique information may impair on evaluation. Again however, because of the asymmetrical design of the game, sharing unique information would be an instance of cooperation, which is desired outcome of the games design.

Design and Implementation

This chapter will discuss the design objectives of this project, the development of design and aesthetic choices, as well as the implementation of the research game.

Design Objectives

One of the key design choices within this research game was to provide asymmetrical gameplay to the players. It is crucial to understand the reasoning for this because of the relationship it plays in the research question of this work, which examines how asymmetrical gameplay facilitates communication which in turn provides transdiegetic sound for the player.

Essentially, asymmetrical gameplay presents the opportunity to provide different levels of information to the player, and within the context of this research in particular, through different modalities.

As discussed previously in the literature review regarding the hidden profile's paradigm, when parts of a problem to a situation are presented separately to individuals within a group, no group member can detect this best solution on the basis of her or his individual information prior to discussion; it can only be found by pooling the unshared information during group discussion.

In this scenario, information of the game environment has been provided to separate players via separate modalities. It may be possible to navigate through the game environment based solely on the feedback of one modality, but it would not be the strongest solution.

As designers we can ensure that the best solution to the situation the game presents is one that is based on all levels of information by designing the environment in such a way that one would require both audio and visual feedback to best navigate within it.

One such way of doing this is to present certain objects within the game space that act as a key to continuing moving through the game world, but have this object invisible, and only perceptible via the sound it emits.

Thus, whilst the player who can see the game space is capable of moving around the environment, they will require the auditory information to be communicated to them in order to locate this object.

This communication within an asymmetrical game is an intentional design objective because whilst players are fully able to play the game without discussing the sensory feedback they are receiving individually, progression through the game and completing the games objectives will require a certain level of synchronization between players so that they have the fullest understanding of the game state.

This communication is what creates the transdiegetic sound for the players. This is because of how the communication between players is also an input to the game which determines behaviour within the game. If players communicate at a high volume, it will alert enemy AI within the game. This change within the game state causes two things; the enemy AI when on alert which provide audio feedback so that one player understands that a change within the game state has occurred. It also manoeuvres the enemy towards the player character, increasing the difficulty for the other player to navigate around it. Colliding with the enemy AI in this instance results in an endgame and the game resets.

Because of this, players control of their communication with each other will be important in handling the situation the game presents most effectively. What this means is that players will need to communicate at a level high enough so that audio player can hear the discussion over the sounds presented by the game, but quietly enough so that it does the raise the alarm of the enemy AI.

It will be an interest of this research to observe whether or not players discuss information in 'hushed tones', and whether their communication influences their sense of immersion. If the players communication does cause the game to respond, it will also be insightful to examine how this trandiegetic sound influences the player immersion.

The game is from the first-person perspective, and the player is presented in a maze environment. There are two levels, which feature different maze layouts. The player starts in one area of the maze, and there are two keys featured in each level. The keys are placed in close proximity of each-other, but are placed from a distance of the player and behind at least one door depending on the route taken to get to them. The keys are placed between the player and the exit, which is even further from the players starting position; approximately as from the spawn point as possible.

Within the maze there are doors that separate the maze into separate areas. The player does not need to interact with them to open, but can pass through them at all times. Within the maze, between the players start point and the keys, is the enemy. The keys do not move, and the enemy does not move unless responding to player noise input.

Within the maze, close to where the player spawns, is an object emitting the sound of a fire. The player cannot interact with this object and it is not visible, but is used to signify to the players that there are elements within the game that may be audible but not visible. The keys are visible, but the enemy is not. The enemy provides two audio cues; one for when it is dormant, and a different audio cue for when actively hunting the player.

With the keys, only one of them is emitting a sound. Both can be picked up, but only the one that is emitting a sound can be used to complete the level. The level is completed by picking up and taking the key to the exit area of the maze. If the player collides with the enemy, they lose, and the game resets.

The controls for the game use WASD keyboard input to control the player movement and the mouse to move the player camera. Pressing the E button can pick up objects and drop them down again.

The sounds of the fire, doors, keys, and player footsteps were provided by samples from providers such as the unity asset store. The enemy noises and background music were produced using the software Logic Pro with a mix of field recordings, drones and vocal samples.

The aim of creating an ambient instrumental with field recordings for background music was to create a sense of atmosphere for the player that was grounded by sounds they may be familiar with such as rainfall, but had been mixed in certain ways that may appear less natural, with the goal being to create tension in the player.

Similarly, the aim of providing the enemy mixed vocal samples was to create fear in the player. With aspects of the overall sound design of the game intended to provide tense / scary moments, the aims of both the diegetic and non-diegetic sounds in the game are to create an immersive horror experience for the player.

The basic visual elements of the game, including the maze environment itself and the key objects, are the result of comprise between aesthetic choices and implementation challenges. As balancing the sound design and implementing the noise detection of the game was crucial, less time could be spent on the graphical elements of the game.

Aesthetic Choices

Because this research focuses on how transdiegetic sound impacts player immersion, the game is predominately an audio-based one. As such, whilst a graphical representation of the environment will be created for the visual player, ideally this be as rudimentary as possible, so that there are minimal graphical distractions to the player when they consider what elements of the game have made them feel immersive. Previous research into the players perception of immersion indicates that there is a focus on the realistic nature of graphical quality within the game, which is something that this research is not concerned with.

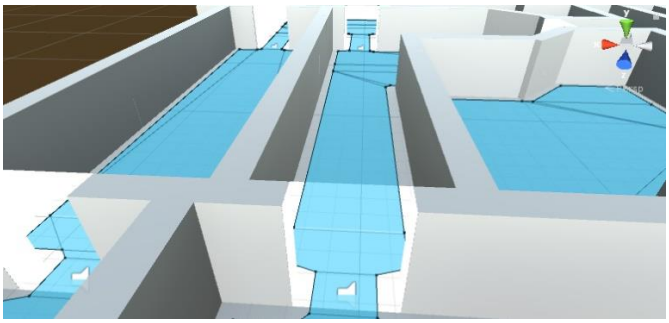

Figure 8- The minimal graphical representation of the maze

What is also worth considering is the different roles that sound plays within the game. Whilst there is diegetic sound within the game such as the noises of player footsteps and the sound emitting from the enemy, there is also nondiegetic sound of background music to attempt to provide an atmospheric environment for the player. Outside of this is the

transdiegetic sound created by the players when they communicate. Aesthetically, by preventing the players from reducing the volume of the diegetic and nondiegetic audio, players are encouraged to speak loudly enough to be audible, which in turn increases the likelihood of interacting with the game by having the voice input change the enemy AI state.

Layout Design

What is worth considering is how the map layout affects how players interact in terms of proximity to the enemy and consequently the emitting sound. The majority of players will attempt to optimise how they navigate a virtual environment (Bjornsson, Y. 2006) so it is important that players cannot bypass the enemy entirely otherwise there is no sound to interact with, which is crucial to the understanding of auditory immersion.

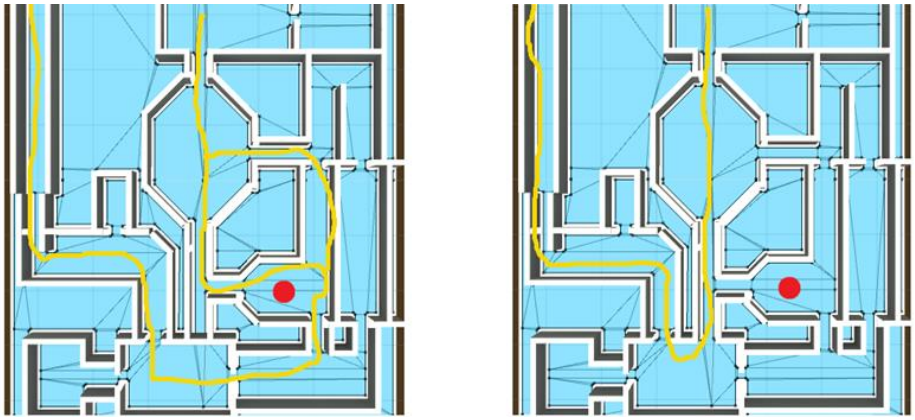

Figure 9- The AI Position is marked as red. The original map layout can be seen on the right. Note the missing wall.

As the Figure 9 highlights, by simply adding a wall in the middle corridor, players are forced to make a turn towards the enemy. They do have the option of circumnavigating around the entirety of the outside area, which does need to be a provided option so that players have the sense of agency in terms of avoiding the enemy. But as it has already been suggested, the majority of players will want to reduce their pathfinding time, so they will try to navigate around the area in which the AI is located (Chin, G. 2017).

The sound positioning of objects within the game is also designed with intent. For example, a key that is required to unlock the door shall be presented next to a key which provides no function. The correct key emits a tone for the audio player to hear. Hence, the player will require to communicate with the audio player to determine which one is emitting a noise (indicating it is the right one) and thus be able to know which one to pick up.

A similar design pattern can be found in the game The Legend of Zelda: Ocarina of Time (Nintendo, 1998). The game contains the Lost Woods area, which contains multiple pathways and players can determine which path is correct by listening to the musical cues the game provides when they travel down a certain path.

Implementation

As one player moves around the game environment using the keyboard and mouse, they will be communicating with the other player who is provided headphones that receive the audio output from the game. This communication, which is picked up by a microphone, affects the state of the enemy AI. If the players become too loud, they will alert the AI, which will start to chase down on their position. The AI will return to a sleeping state if the players remain silent again for long enough.

Using a relative scale factor, the amount of distance determines when the effect takes place. Based on distance, the attenuation of the mixer group goes down, while the send volume to the effect group goes up. With this relationship, the scale factor number is used to alter how far away and how severe with reverb, high pass, and low pass filters affect the sound on that mixer group. If the scale number high, the effects will be more granular over long distances.

The game checks the location of the player and apply the filters accordingly. When the switch is on "inside", the engine applies the filter, and when it is "outside", turns the filter off. The advantage of having a game environment which is consistently located in an interior such as this is that the low pass filter does not need to be adjusted.

The high frequencies of a sound being emitted from behind the wall will be filtered out by the door and so do not reach the listener.

The AI is controlled by a Nav Mesh agent. The environment has a nav mesh baked and once the audio input script registers that the players talking reaches a certain volume, it activates the agent. It navigates around the environment as highlighted in blue, and uses the mesh to ensure that the agent does not collide unintentionally with the walls.

This is another advantage of having no collider on the door game object, as the AI can pass through with the same amount of ease as the player, but when the AI passes through it does not activate a sound cue. This creates auditory tension as the AI does interact in the same manner with the game world as the player, a technique used in horror games such as the previously mentioned Silent hill or P.T (Kojima Productions, 2014)

Methodology

This chapter will provide an overview of the recruitment process, the task and procedure that the participants will be performing, and possible concerns the study may present. This chapter also discusses the hypothesis that the research question presents to the study.

Participants

40 participants (in pairs of 2) were recruited for the study. All participants were between the ages of 18-25, with 25 of the participants identifying as male and 15 identifying as female. All participants were enrolled at University at the time of study, with 19/40 of the participants within the school of computer science. Because of the previous research that discusses players familiarity with their teammate determining their level of cooperation, all participants were also asked prior to the study if they knew the other participant that they were being paired with; 4 of the 20 pairs said yes.

Task

The task that the game provides is to navigate through the game environment, avoiding the enemy and collecting the key object so that when the player character reaches the end goal it can be unlocked, and the game is won. Players are encouraged to communicate with each other and discuss the unique information they each have throughout the game to determine the best solution to the situation the game presents.

Procedure

In terms of experimental protocol, both players were briefed at the same time. After introducing the research topic, they were provided an information sheet which contained a description of the project task. The information sheet also contained an explanation for controls within the game. and asked to fill a consent form. Once completed, they were both told that each round of the gameplay session would last 10-15 minutes, and that after each round, there would be brief survey that would take roughly 5 minutes for them to complete.

Prior to the study, participants were asked if they would consent their gameplay sessions being recorded for transcription. Players were seated during the study within the same room and a single device was used to record participants dialogue. Notes were also taken by the researcher as the gameplay sessions were being observed. Each gameplay session lasted for 10-15 minutes or until the player reached the end goal. After that, both participants answered an IEQ (Immersive Experience Questionnaire).

After this, the pair of participants switch roles, and a second gameplay session lasting 10-15 minutes occurs. Once this second gameplay session was finished, both participants answered the IEQ again. The questionnaire also included a space for the participants to leave notes or comments about the game. Participants were also asked about their previous experience with multiplayer games and voice communication.

The second set of questionnaires were followed by a semi-structured interview with both participants as a group discussion. There are five core questions, relating to questions asked during the IEQ. All participants were asked these same five questions but were free to discuss other elements of the study.

Risks and Concerns

The room acoustics for the area in which the study was conducted was measured using the recording device. This was to ensure that participants microphone input volume was consistent throughout the study.

There was a chance of some slight discomfort or confusion from participants being unable to visually identify interactions within the virtual environment. As a result, participants were made aware of the voluntary nature of participation and were informed that they have the option to withdraw at any time if they so wish. Also, because the research intended for players to communicate, and since the variable of player communication is external, participants may have been at risk of discomfort and were therefore encouraged to behave in a polite and appropriate manner during gameplay sessions. Player gameplay and voice communication was also recorded to observe player behaviour, and so participants were made explicitly aware of this and were free to consent to having their interviews and gameplay recorded.

Study Hypothesis

The hypothesis being tested in this study is that interacting with the game will result in player communication creating immersive transdiegetic sound. It is believed that player immersion will be highest after having played both modalities, because it provides the player will have the better understanding of the games mechanics and the game environment they are within. It is hypothesised that player immersion will be lowest if their initial engagement with the game is with the graphical modality, because of the rudimentary design would which provides little visual feedback. It is assumed that there will be an overall net positive increase in player immersion, as players who started with the visual modality are able to experience the auditory gameplay in the second condition, and provided with auditory feedback that expands upon their previous play experience.

Results

This chapter will highlight the results of the study, and discuss both the quantitive and qualitative data that has been provided in responses. This chapter will also examine the

thematic analysis of the study and provide an insight into some of the emergent themes of this research.

Data Collection

This study used a mixed methods approach to collect data from participants. Quantitive data was collected from participants in the form of the IEQ (Immersive Experience Questionnaire) which was presented individually to both participants at the end of each gameplay session. Qualitative data was collected by using a semi-structured interview with both participants and transcribing the responses.

Scoring the IEQ

The immersive experience questionnaire (IEQ) measures the subjective experience of being immersed whilst playing a video game. To calculate the immersion score, the IEQ states to add up the responses to all questionnaire items; some responses are reversed depending on how the question is phrased. Questions are related to the five immersive factors, described by Jennett, C. (2008) and are: cognitive involvement, emotional involvement, real world dissociation, control and challenge.

The first step was to examine how participants who started with the visual game session changed their responses after playing the second game session, and compare this to participants who did this in the reverse order.

For participants who started with the visual gameplay session first, the average immersion score was 54. This rose to an average of 65 after playing the audio version of the game. This sees an increase in immersion but is not considered significant. In comparison, for participants who started with the audio gameplay session first, the initial average immersion score was 77. This dropped slightly to an average of 73, but this is still on average higher than participants who played the game in a vice versa order.

Thematic Analysis

All participants completed the gameplay sessions, with no participants running out of time before achieving the intended goal. Data has been collected from this study in the form of results of the IEQ.

Semi-structured interviews from the studies have also been transcribed and processed using a thematic analysis. This analysis organized the transcriptions into different themes, which were determined by preliminary codes; these codes relate to the questions from the IEQ.

Code	Question from IEQ (Immersive Experience Questionnaire)	Frequency
21	To what extent did you enjoy communicating with your teammate?	19
20	To what extent did you enjoy the audio and narrative?	18
22	To what extent did you have a sense of the enemy presence?	13
6	I enjoyed the graphics and imagery.	12
11	I could interact with the world of the game as if I was in the real world.	6
19	I felt as though I was able to mentally create a map of the environment.	6
7 / 23	To what extent did you enjoy the game?	6
18	I felt I could locate objects that were interactable.	5
1	I felt that I really empathised/felt for with the game.	4
3	I was interested in seeing how the game's events would progress.	4
4	I was in suspense about whether I would win or lose the game.	4
8	The controls were not easy to pick up.	4
5	I wanted to speak to the game directly.	3
2	I did not feel any emotional attachment to the game.	2
9	I became unaware that I was even using any controls.	2
12	I was aware of surroundings.	2
15	I did not feel the urge to stop playing and see what was around me.	2
16	I still felt as if I was in the real world whilst playing.	2
17	When playing the game time appeared to go by very slowly.	2
13	I felt detached from the outside world.	1
14	At the time the game was my only concern.	1
10	I felt able to be travelling through the game according to my own volition.	0

Part of the difficulty of using a thematic analysis is how certain transcriptions could be considered to fit a range of codes, which may impact what themes appear to be emerging. Because of this, after the analysis was complete a data session was presented to a fellow

researcher to gain a second opinion on if the themes had been appropriately determined and supported.

Theme	Corresponding Codes	Frequency
Sense of in-game interaction	[11],[18],[22]	24
Player communication	[21]	19
Auditory immersion	[20]	18
Graphics and imagery	[6]	12
Playability	[8],[9],[10],[19]	12
External distraction	[12],[13],[14],[15],[16],[17]	10
Emotional connection	[1],[2],[5]	9
In-game progression	[3],[4]	8
Player enjoyment	[7],[23]	6

As the table displaying the preliminary codes show, the frequency of codes appearing was also noted. This was to better determine what patterns in the transcriptions were most prominent, and also gain an understanding on what the semi-structured interviews focused on. In this case, it is assuring to see that themes of player communication and auditory immersion were some of the most frequently discussed, as these directly relate to the topics that this research is concerned with.

It is worth stating before discussing the individual themes that the theme of auditory immersion is based on the assumption that diegetic sound (player footsteps etc.) and non-diegetic sound (the background music within the game) are to be classified in this section, and any references to what could be considered transdiegtic sound (in this case, voice input from outside of the game space) is instead included within the theme regarding player communication.

The quotes below are referred from the interviews and are supported by the quantitative results from the questionnaires, unless stated otherwise. Each quote notes the identifier of the participant who made the statement.

Player Communication

The majority (65%) of participants responded by saying that they agreed or strongly agreed that they enjoyed communicating with teammates. When creating preliminary codes based

on questions from the IEQ, the transcriptions showed that the most frequently occurring code was that which was in relation to player communication. Reviewing the transcriptions does suggest that there was an overall positive experience of player communication though, which is supported by the previously mentioned results of the IEQ.

"It was fun talking and trying to solve the puzzle together." (10)

It could also be suggested that the enjoyment of player communication was to such an extent that several participants responded by saying that they would prefer to have more instances of it.

"I think the talking to each-other part is fun, I think it should happen more often though." (24)

It is also worth noting that 80% of participants had met their teammate for the first time during the study; There were some participants who noted that they may have had a preferable experience if they were playing with some that they recognised.

"Would like to try again and talk with someone I know" (11)

It should be noted that quotations with a negative connotation regarding player communication were solely made in the feedback sections of the IEQ rather than mentioned during the interview process. This may be because of the difficulty players may feel of being critical about the person they were paired with in the study directly, possibly because of not wanting to appear rude or impolite. The other reasoning for a negative discussion of player communication generally revolved around the limitations of technical implementation of communication rather than the experience of using it.

"After the first two times of me saying 'what did you say?' I felt really awkward to keep asking." (29)

This quote in particular is also interesting in terms of the games design. By describing the situation as awkward, the participant highlights the potentially uncomfortable situation that arises when playing games with a stranger. As discussed in the literature review, previous studies have attempted to mitigate player discomfort when first engaging in voice communication with strangers, through the use of icebreaking tasks (Hicks, K. 2017).

The research suggested that these tasks can contribute to a positive voice communication experience, although their inclusion can create further issues to be considered for successful integration.

“It felt like we could never chat for too much otherwise we wouldn’t be able to hear the monster.” (9)

It also highlights a core part of the game design, that being volume control. As there are already a multitude of sounds within the game, players need to be able to speak loud and clearly enough to be heard, but quietly enough that they do not disturb the enemy AI. This type of volume output control is not normally seen in games, and so participants may not be used to or comfortable with the task.

Audio Immersion

70% of participants responded in the IEQ that they enjoyed the audio elements within the game. One of the issues of grouping codes into this theme during the thematic analysis is that the original IEQ has the question ‘To what extent did you enjoy the audio?’ but as the research question is an analysis of transdiegetic sound, it becomes difficult to determine what level of diegesis the participants may be referring to when responding to this question.

The effect non-diegetic audio had on the players sense of immersion was a frequent response. Several participants noted that the music for the game conveyed a sense of atmosphere and mood in more impactful way than the graphical elements within the game environment.

“The music was really tense, and I think that helped me get into the zone, as well as being on my own in the room and closing my eyes helped imagine things.” (26)

Though it may seem that the number of players who responded by saying they had a neutral gameplay experience has increased, we can see that overall there is a net positive increase of participants who enjoyed the gameplay experience in the second scenario. It is also noteworthy that whilst some participants may not have changed their response from neutral after the second scenario, none of the participants responded with a decrease in enjoyment after the second scenario. It could then possibly be inferred that participants who at first were playing the graphical version of the game were not having a positive experience of the game, but that the audio section recontextualized their understanding of the games environment which increased their sense of enjoyment.

Limitations of the audio development within the game may have negatively impacted the results which relate to audio immersion. One improvement that was suggested in the

interview process was to implement functionality that would allow the player to change volume settings within the game.

"I think the thing for me is being able to hear certain things easier. If there was a way to adjust the volume that make things much better, and making the sounds more obvious of their location." (25)

This feature was considered during the design of the project, but it was considered that if participants were provided different levels of audio feedback during the study it may have provided inconsistent results when determining their responses to the theme of audio immersion. Another limitation of the audio development was the difficulty in replicating spatial sound in the game environment, which may have directly affected some participants understanding of the game space.

"Having different sounds for when it's in a different room, whether or not the door is left open, that kind of thing." (26)

One of the questions within the IEQ was about whether or not participants could interact with the world of the game as if they were in the real world. Another asks to what extent did they feel as though they were able to mentally create a map of the environment they were in. Though these don't directly fall into the theme of audio immersion, if the player does not feel as if the games audio engineering is accurately portraying the soundscape of the environment, the inconsistency may break the players sense of presence which does relate to immersion.

Graphics and Imagery

As evidenced by the frequency of the codes relating to this theme, the graphical elements of the game were a recurring topic of conversation during the interviews. As evidenced by the IEQ, the majority of responses were negative. 30 out of 40 participants answered the questionnaire by saying that they strongly disagreed or disagreed with the statement that they enjoyed the graphics and imagery of the game. This is not too surprising; the visual elements of the game were not a focus of the research or design process, and were merely at a functional level. The responses from participants reflect this.

"Yeah just things like that make it more interesting to look at. The fire and key was okay but the rest of it weren't very interesting to look at." (2)

Some participants also described what they would prefer to see in a future design of the game. This is useful because if the graphical quality was the biggest limitation for players

feeling immersed, having an understanding of what elements they would think would increase immersion is helpful.

"I wish there was more details in things, because even if the colour is the same, can always be more interesting to look at with textures and stuff." (21)

A few of the participants did respond positively, stating that they enjoyed the simple style of the visual elements, and was easy to observe. This is related more to the playability of the game rather than the players level of immersion, but is useful nevertheless.

"Yeah I liked the minimalist style, it was a lot less stressful to play that compared to the audio version." (10)

Emotional Connection

This theme was mainly concerned with the players level of empathy during the gameplay experience and their interest in the narrative elements of the game. Understandably, this topic was generally perceived negatively by participants, mainly due the lack of any characterization or narrative context for the gameplay.

"Yeah I didn't care about the character or story because there basically wasn't any was there." (13)

What is most interesting about this theme is how it contrasts to other themes within the thematic analysis. There are a multitude of quotations such as the one above where participants described not really having much of an interest in the emotionally caring about the situation of the game.

"I wasn't emotionally connected to it or anything like you would in a game like The Last of Us, but I still cared about winning." (30)

As the end of this quote suggests, emotional connection contrasts with the theme of in-game progression, and how participants wanted to continue playing to achieve the games objectives, despite not having a narrative motivation to do so.

Another code that supported the sense of an emotional connection was participants describing that they wanted to speak directly to the game. This question in the IEQ may have confused several players, who responded by discussing how they assumed that they had been talking directly to the game because of the voice input mechanics.

"When asked if I wanted to speak directly to the game, I thought I was when I was playing". (7)

This would suggest that the IEQ itself may not always be appropriate for the game depending on what design and mechanics it implements – a point to focus on during the discussion section.

Sense of in-game interaction

In-game interactions in this case was roughly defined by the players sense of being able to interact with objects or the environment, and that the game would respond to the players input as expected. This is distinct from the theme of playability, as the sense of in-game interaction is concerned more with the game behaving as the player would assume and having a consistent contextualisation.

A pattern that appeared in the transcriptions relating to this topic was the players perceptions of the doors throughout the environment. This is also mentioned in playability, but there were also instances where what the audio player could hear did not seem to naturally correspond to what the visuals player could see.

"Yeah it did feel like walking down corridors, and felt weird that you could walk through the white walls and it would make a door noise but it didn't actually look like a door." (1)

This again may be due to a lack of foresight during the design and development stage. When playtesting before running the study, the issue that the white wall did not inherently appear as a door was never raised. This was probably due to the developers familiarity with how the white wall functioned. This was described to participants during the briefing but may need to be clearer.

"That's the thing, they weren't really doors. It sounded like doors when you were listening but it looked like these white portal things." (13)

"Because the first time round hearing it I was like oh that's a door being opened, but then to play it and see this white wall I thought it was supposed to be a window or something. But then when I walked through and you said the door was being opened I was like thats it?" (26)

Aside from the problems that participants had with interacting with the door, players appeared to have a relatively good sense of interaction with the environment.

The interactions with the enemy AI were perceived as being enjoyable, which is useful as it is a key mechanic within the game.

"Trying to avoid being caught was fun, because it felt like I was really interacting in the world." (11)

"The key and door were good in that it was clear we had to do something with them." (10)

Players also found the interactions with the key object easy to infer and enjoyed the moderate sense of weight that the key had whilst carrying. There were some issues identified with the lack of feedback presented to the player, however, when first interacting with the key.

"I would have preferred to have something like Portal 2 where when I aim at the key it glows or there is some text that pops up saying "press E to pick up" but otherwise yeah no it was good." (7)

Portal 2 (Valve, 2011) is an interesting comparison because that game is a good example of the slight details such as a controller vibration or slight noise can notify the player that they are successfully interacting with the object. For future reference, this would be useful when designing a game with a similar concept to this one, because that feedback could be presented to the audio player so that they are also immediately aware that the interaction has taken place. The audio emitting from the key gives the audio player a sense of proximity, but there is otherwise no change of state when the key is picked up or dropped.

In-Game Progression

This theme is about the players sense of advancement within the game and a desire to continue playing. Several participants described this sensation of wanting to find out what would happen next, although some noted the short length of gameplay as being an issue regarding this topic.

"At first I would say I was immersed because I thought something was gonna happen, but after a while I was like 'Oh that's it' and got kinda bored to be honest." (11)

A reason for this may have been due to limitations of the game design. Only two levels were designed and developed to accommodate the number of participants per study, and it was difficult to determine aspects such as size of the environment and complexity of the maze.

The reason for this was that what may be quite a simple task for an experienced player when they can see the environment, may be very difficult for a casual player when they can only hear the environment. Players did also describe the desire to complete the objective of the game, but again with the response that this may have been due to their competitive nature.

"Like, I cared about winning but that's just because I like to win at games. I don't think there was anything more about this game." (23)

Playability

Playability was made into a separate theme because even though this research is not specifically concerned with usability, if players find the game difficult to control then it can naturally lead to player frustration, which can be a detriment to their sense of immersion and enjoyment in game.

"I found it a little hard to move around in a way that felt good, I felt like I was getting a bit lost." (17)

The participant admitted that they were not normally who plays first person games, so having a difficulty moving with the control scheme using a mouse and keyboard if they did not have prior experience is understandable. What is interesting however, is how they felt lost during the game.

"I think it's because I didn't have a mini-map or anything so I found it hard to remember where I was from the start point." (17)

This directly relates to question 19 of the questionnaire which asks the participant if they felt able to create a mental map of the environment during the gameplay. This question was not originally in the IEQ but constructed to determine how players felt specifically for this game, which required a relatively large amount of navigation. Some participants also supported this feeling lost, especially when related to how some elements of the game did not behave the way they may have expected.

"That was annoying, because if it was just a door that you could open and leave open, it would be easier to remember where I had been already, like in PUBG. Otherwise I had to try and guess if I had been through the white wall or not." (19)

External Distraction

This theme is concerned with codes that were about the participants being aware of their surroundings, if they were paying attention to the time etc. Its low frequency does make it more difficult to discuss at length, as there were fewer responses that fall within the theme, but there are some responses that are of note.

"Closing my eyes made things a lot scarier, because it would be distracting being in the room." (20)

The setup of the study tried to mitigate distraction for the audio-only player by positioning them in such a way that they would be facing a blank wall or the least visually stimulating area of the room. It was also suggested to participants that closing their eyes may help them focus on the sounds, but this was not required of them.

It is also interesting to note how certain stimuli within the game determined if a participant was focused or distracted during the gameplay session. One participant for example, described their reaction to hearing the sound of rain within the game.

"I did peak out the window when I first heard it because it sounded like, out of the game." (30)

This is contrasted by another participant discussing the most ambient drone noises within the game.

"Like I didn't know what instrument or noise was that was like the long drone sound, but it instantly made me feel separate from the outside world which was cool." (29)

Discussion

This section will examine the results presented above and discuss the implications in relation to the use of the IEQ, as well as the general perception of transdiegetic sound as an immersive mechanic.

What is noteworthy is that a substantial part of the IEQ is made up of questions regarding 'being focused on the game and not on outside distractions' – 6 of the questions relate to the theme of the player being able to separate concerns from external modalities not included in the game space. Yet several of these codes had the lowest count in terms of when they were mentioned in responses to interview questions.

Perhaps this is misplaced importance on the questions, or perhaps it was a fault of the interview preparation process to not bring up these themes with more emphasis during the

questionnaire. It may also be a lack of context for the players regarding defining immersion before answering questions regarding it.

For example, one of the questions regarding immersion in the IEQ is 'I found myself to become so involved with the game that I wanted to speak to the game directly'. Several participants commented afterwards that they were unsure if this was in regard to the way that they communicated in the study.

"When asked if I wanted to speak directly to the game, I thought I was when I was playing". (7)

This would suggest that the IEQ itself could benefit from clarification when being used for games that do allow for voice input from the player. It may also be beneficial in future research of player experience and immersion to first ask the participants what their understanding of immersion is, and examine what level of familiarity the participant has.

One of the interesting patterns that emerged from the results was a concept of immersive moments – instances of the player feeling immersed at a particular point in the game, or because of an event that occurred to trigger an immersive feeling.

For instance, the theme of 'sense of in-game interaction' appears frequently in the thematic analysis, and as it has been suggested from the design of the games mechanics, there is relatively few amounts of actual interaction available within the game. Doors are opened automatically and being able to pick up objects offers little in the way of player expression, so the core interaction lies within the reaction of the AI to the player's voice input.

'It was scary when the monster first got us because I couldn't see it'. (9)

The inconsistency of modalities presented in-game with regards to the monster in comparison to other elements of the game (Fire can be seen and heard, but the monster can only be heard) present a moment of surprise for the players expectations. These expectations are also challenged when the player's voice input effects the monsters game state; several players described feelings of not realising that the game was also detecting the players voice input.

By reviewing the responses that were included in the theme of communication and in-game interaction, it appears as though the assumption was that the microphones provided where solely for player communication, and not for also interacting with game.

The concept of player enjoyment also contrasts with the theme that arose regarding emotional connection. 55% of participants stated that they disagreed or strongly disagreed with the statement that they felt empathised / felt for the game. It would be assumed a low level of emotional connection would negatively impact the participants sense of immersion and thus effect their level of enjoyment. But there are a multitude of responses that indicate a players sense of enjoyment.

"I realised talking too loudly would change the game, it was fun, and I would do it on purpose". (21)

This is interesting because it suggests that though the player may not be fully immersed in the sense that they were intentionally toying with the games mechanics in a way that was not intended, they still felt a sense of enjoyment from playing the game. This would suggest perhaps that though emotional attachment may increase immersion, a low level of immersion does not necessarily mean that players aren't willing to continue playing the game and enjoying it.

However, the objective of this research project is to determine what impact transdiegetic sound has on the players level of immersion during the game experience, and not how it effects the sense of enjoyment. It is useful, however, to clarify the differences between the two so that the outcome of results can be clarified.

An interesting aspect of the players sense of audio immersion was also how it affected the players behaviour from a mechanical aspect. Several participants reported that cues from feedback in the diegetic sound within the game space influenced their decision making when navigating the game.

"I thought the way you could hear your own footsteps really loudly over everything else was really well done, it made it harder to hear the monster, so you had to actually be careful about when you were moving." (14)

This again highlights the relationship between audio immersion and player communication – the player navigating the environment would only know to stop moving if the other player being able to hear the monster made the game state understandable.

This also shows the interplay between the transdiegetic sound (The voice communication between players is also the causation for the AI's change in behaviour) and the diegetic sound (the sound of the in-game footsteps and AI sounds). Players who can communicate

effectively and manage their transdiegetic input also mean that they would have a clearer understanding of the diegetic sound within the game space.

As the discussion of results shows, one of the difficulties of attempting to determine the outcome of the research study is the relational nature of themes within the thematic analysis. In the context of this research project, topics such as player communication and audio immersion may be separate themes but have such a direct influence on the other, that it can almost seem arbitrary when trying to categorise the participants responses.

What this does suggest is that there are several factors that are result in the player having what was previously described as immersive moments, and this experience is limited in terms of duration in comparison to the total gameplay session time. As a result, the limitation of questionnaires and interviews that provided to the participants at the end of a gameplay session are a reflection of the total gameplay session, rather than moment to moment experiences that the player feels.

“the time we were talking a bit loud and the game sound jumped up that was scary, but that only happened like once or twice right. So, I guess I was immersed then, but that’s only a short time to be scared.” (19)

A suitable alternative to this would be a recording of the participants responses during the gameplay session, with a real-time analysis of their reactions to specific in-game events that could be determined to be immersive. As the results have proposed, moments in the game that encourage high levels of player communication and a strong sense of in-game interaction facilitate the players sense of immersion. Because of this, it becomes easier to identify what events in the game could be labelled as ‘immersive moments’ and thus make them an easier point to measure player immersion.

Upon reflection of the limitations of the methodology, there are areas in which data wasn’t captured but could have contributed to the project. An example of this would be to record player conversations during gameplay. This would enable the results to provide insights such as frequency of player communication, as well as highlight key moments for player communication. Player feedback in the interviews after the gameplay session was complete may not fully reflect the experience during gameplay. Another example of data that wasn’t captured which may have been useful for discussion is recording the paths and routes taken by the players within the levels during gameplay, which could be done with a heatmap technique.

When looking at the thematic analysis it is also worth noting limitations of the game design itself. With the design intention to be asymmetric both mechanically and in terms of modalities provided to the players, there are alternate combinations that could be explored. This project provided one player the ability to hear game audio and communicate with the other player, and the second player the ability to see game graphic and communicate, but the second player was also provided the ability to control the avatar movement. It is possible that player immersion and experience, as well as their styles of communication, would be different had the player who could hear the game but not see it be provided with the movement controls instead.

Conclusion

This chapter will summarize the body of work that has been carried out in this research, and examine if the objectives of the research question have been satisfactorily answered. This section will also discuss limitations of this research, and how it may be expanded upon in future work.

Thesis Summary

To conclude this work, it can be said then when analysing the quantitive data provided by the study, there is not a significant relationship between the transdiegetic communication between players in an asymmetrical game, and the immersion the players experience individually during gameplay. However, the thematic analysis performed for the qualitative data provided by interviewing participants does suggest that the relationship between transdiegetic sound, player communication and immersive experiences may exist; further research would be necessary to determine this interplay between concepts.

It is difficult to examine how a single element of a games design (in this case, transdiegetic sound) impacts player immersion because of the variety of variables that determine how immersive the player experience can be, and it may be a difficult endeavour for future research to attempt to analysis a single design pattern within a game in isolation, because of the relationship all design choices share with each other when attempting to provide immersive experiences.

However, this research does propose guidelines to inform future game developments which may make the use of transdiegetic audio in the form of possible game design patterns. As discussed from the results of the thematic analysis in regards to player communication and audio immersion, the use of transdiegetic audio can be tool to provide

opportunities for immersive moments when developing games that may use voice input or other noise detection capabilities that external from the game environment. This research supports design choices shown by games such as Alien: Isolation that by using transdiegetic sound mechanics in certain situations, player immersion may be increased. This works for games in which gameplay revolves around shaping behaviour in a desired way, such as horror or stealth games. Having the players require to use restricted communication and rely on vocal control to avoid being detected by the game's enemy AI can lead to tense and immersive moments, which supported the intended goal of these genres.

These opportunities for transdiegetic audio providing moments of immersion do come with potential issues such as the initial requirement for voice input being off-putting to players or the reliance on other players communicating information to complete the game requiring careful balance of the players roles. However, based on the findings of this research and the literature that it supports, the proposal of using transdiegetic audio as a game design pattern may still be used for future game development.

Discussion

One theme that did arise during the analysis of qualitative data is the concept of immersive moments; the idea that it can be difficult to retain high levels of player immersions through the game session because of the multitude of variables that can influence the players experience. Related to this though is there can be significant moments within the gameplay that heighten a player's sense of immersion for particular reasons.

In this research it was found that moments when participants felt more motivated to communicate to facilitate navigation within the environment led to increases in immersion. This idea of immersive moments is supported by the Player Involvement Model (Calleja, G. 2007) when viewed from the micro level - the micro phase of the model focuses on the moment by moment involvement of the game-playing instance.

Limitation and future work

One of the issues that was noted during the study for this research is that when attempting to analyse player immersion, there can be a disparity between what the player determines is 'immersive' and the academic communities' definition on player immersion. To avoid this problem, it is advisory to future work in analysing immersion that the concept of immersion is clarified to participants before they respond to questions about the topic. This can take the form of definition of the concept presented before the questionnaire. The study in this research suggests that players associate immersion with enjoyment, which may not always

align and in the games research community though closely related, are distinct from each other.

From a technical standpoint, one limitation of the development of the research game was the understanding of sonification within virtual world. Several participants noted in their responses some of the flaws in the sound design of the game, such as unrealistic audio occlusion. Within an audio-based game, this is detrimental to the interaction between the players and game which can significantly impact the answer to the research question. For future research into this topic, a stronger knowledge of the audio development pipeline within the game engine would be necessary.

Another limitation with this work is that as discussed in the literature review, no single scale has been established as a norm, which makes comparison between studies problematic. This can also lead to difficulty when first embarking upon research into player immersion. In this work, it may have been useful to support the questionnaire used to gather quantitive data from participants by using a secondary questionnaire such as PENS (Player Experience of Needs Satisfaction). The difficulty still arises that when applied to games with novel mechanics such as this one, certain questions may not be applicable. For example, questions that concern themselves with graphical quality, when the game is audio-based. For future work, it may be useful to gather a stronger consensus on what questionnaires are suitable for measuring immersion, and attempting to expand upon existing methods for niche genres.

Appendix

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