Spatial Sound and Psychological Response

Analysis of immersive audio techniques in games.

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ABSTRACT

To create a psychological response from an individual, an immersive sound experience is necessary; a comparative evaluation of three key players in the game development industry have implemented techniques such as binaural audio, and spatial sound; Perception (2017), Hellblade (2017), and Uncharted 4 (2016). Unity3D engine offers simple functionality to implement these features, suitable for Indie developers, which will later inform the decisions of future projects. The findings suggest that binaural audio and spatial sound will affect the immersion, psychological response, gameplay, mechanics and story of a game significantly, leading to success if done correctly.

Keywords

Spatial sound, Psychological response, Ambisonics, Binaural, HRTF, Head Related Transfer Function, Stereophonic, Monophonic, Hellblade, Perception, Uncharted 4, Unity3D, Interaural Time Difference, Interaural Intensity Difference, Spectral Difference

1. INTRODUCTION

This paper offers an investigation into the field of spatial sound and how the effects in the real world can be transferred over into game-based technology. An analysis of techniques for Binaural hearing and spatial sound are comparatively evaluated with three key players.

A focus on how these sound techniques influence an individual's psychological response is discussed in a variety of genres. A psychological response can be very engaging and immersive for the player experience, and adding to the gameplay, mechanics and story.

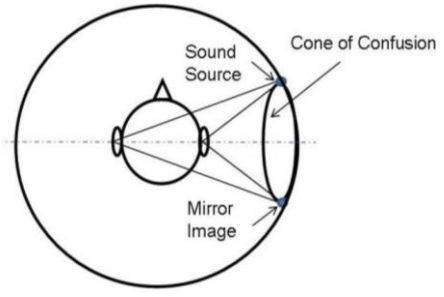
2. FIELD

With an exponential growth forecast of the Virtual and Augmented Reality market size (Statista, 2018) [3], the utilization of all sensory input becomes more prominent for increasingly immersive user experiences. (Collins, K.) [2] theorizes that sound is immersive '… through the sense of sonic envelopment.', a term summarized by (Berg, 2009) [1] to be '…the sense of being surrounded by sound.'. This envelopment of sound can be observed in the physical world through Binaural Hearing. Species with two ears have evolved to process sound in such a way, that it is possible to determine the direction and distance of the source, which is perceived through two auditory cues proposed by (Roman, Wang and Brown, 2003) [6]; interaural time differences (ITD), and interaural intensity differences (IID), however (Larsen and Pilgaard, 2018) [4] emphasize a third component 'spectral differences (SD)'. This is how we filter out multiple sound sources and block out interferences, which has coined the term 'Cocktail-party Effect' (Roman, Wang and Brown, 2003) [6].

The effect of ITD is caused by the proximity between the two ears. The sound waves will take slightly longer to reach one ear, dependent on the rotation of the head towards the source. IID is based on the absorption of sound from the head; for instance, a speaker set-up to face the right ear would perceive a significant amount of intensity compared to the left. Finally, SD is induced by the reflections and absorptions of the body, which will in-turn alter the sound intensity at different frequencies (Larsen and Pilgaard, 2018) [4]. ITD is mimicked in games that make use of 3D spatial audio for an immersive experience, and to form a psychological response, most notably to alert the player cognitively and physically about their surroundings.

Although the concept at first glance is feasible to be used in games, 'People can make errors when localizing sound…', (Larsen and Pilgaard, 2018) [4] suggests. Depending on whether the sound is directed from behind, front, up or down, the user may be subject to the 'Cone of Confusion'. (See Figure 1.) Research suggests that the issue can be resolved through head movements (Minaar et al., 2001) [5], which is ideal for a large speaker set-up, however for headphone users this could present a problem to overcome, due to the lack of SD feedback.

Figure 1. Cone of Confusion (Letowski and Letwoski, 2012)



3. KEYPLAYERS

There is difficulty in identifying sources where spatial sound is present unless referenced or stated by the developers of the techniques they used. This section analyses and evaluates the use of spatial sound techniques in three games, and an explanation to why a psychological response could occur.

3.1 Perception (2017)

Released on the 30th May 2017 by The Deep End Games, Perception (Perception, 2017) [7] has been a unique addition to the survival horror/adventure genre, with its take on the visualization of sound through the lens of a blind character using echolocation. The desensitization of visual sensory input

provides the user experience and game mechanic to revolve around sound. (See Figure 2.)

Figure 2. Perception Gameplay (PlayStation, 2018) [21]

An important factor in survival horror games is to create a negative psychological response to prompt the user to feel uncomfortable or fearful. Players seek this negative due to 'Motive-Inconsistent emotions' as suggested by (Perron, 2005) [8]. Perron discusses the positive and negative emotions of a player '… is consistent with the person's goals, intentions, and motives.' (Perron, 2005) [8]. Even though the sounds in the game may induce a high fear response, the player will find pleasure in overcoming this obstacle.

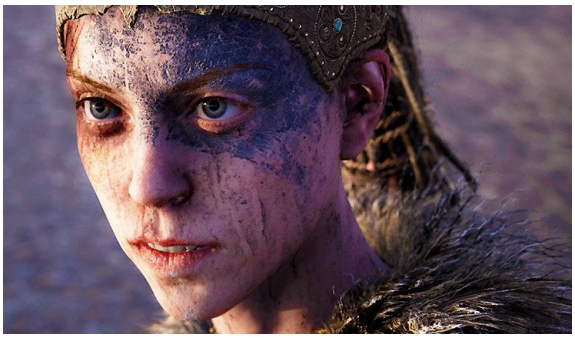
Perception uses Monophonic channels for character exposition in a first-person perspective, while other additions to the environment are mapped with Stereophonic channels for spatial immersion. With stereophonic channels the user should be able to determine the distance and direction of the auditory source; Binaural Hearing but in a virtual world. Sounds closer to the player stimulate a higher level of fear (Garner and Grimshaw, 2011 as cited by Larsen and Pilgaard, 2018) [10][4], and in-turn could cause an increase in Cardiovascular activity, in terms of a higher heart rate or a fight-or-flight response. This response to sound will add to the immersive experience, presenting itself as an obstacle that motivates the player to press forwards.

However, if the ideal is to create an even higher fear response then the sound should be loud (Toprac and Abdel-Meguid, n.d.) [9], as softer sounds are likely to go amiss due to other sources; such as the deep resonant ambience that is apparent throughout some scenes of the game. A close loud sound with a sudden visual is often associated with 'jump scares', and if relied upon entirely, the immersion could be broken. Perception finds a balance between the sounds that startle the player and the sounds that sustain atmospheric tension throughout.

3.2 Hellblade (2017)

Hellblade (Hellblade.com, 2017) [11] released in 2017, is a self-proclaimed AAA game developed by Ninja Theory. While the story could be taken in a literal sense, it also has an underlying meaning; towards Senua's (the main character) struggle with psychosis. (See Figure 3.)

Figure 3. Hellblade (Birch, 2018) [22]



To represent psychosis the sound design team worked with Binaural Recording devices (3Dio, 2018) [12], as referenced in the company's development video logs (Ninja Theory, 2017) [13]. This improved the atmosphere of the game, but also created the illusion of others whispering in the players ears or speaking to the player, as if within a proximity of them. An unnerving, yet pleasurable experience due to an Autonomous Sensory Meridian Response (ASMR). (Barrat and Davis, 2015) [14] research suggests 'individuals experience a tingling, static-like sensation across the scalp, back of the neck…', a psychological response to sound stimuli. The whispers and personal attention of the voices in Senua's mind trigger ASMR. To an extent, this forms relaxation in the body as ASMR would suggest, but rather the reality of psychosis shapes an unsettling experience as the game progresses, an integral unique selling point to this psychological horror/dark fantasy action-adventure game.

Using spatial sound, the implementation of a sound-based head-up display (HUD) was important to keep the player immersed in the world. The Lead Audio Designer, David Garcia stated; 'I created the logic that lets you place sound objects in the world. Based on the distance and angle from the player, the sound is modified so that it can be used to guide you' (Ninja Theory, 2017) [13]. This could potentially result in problems with individuals that do not have good quality stereophonic speakers or headphones. The system is heavily reliant on the sound systems that the purchaser has, and the Binaural Hearing may not be present due to the user only possessing monophonic hardware.

In relation to Perception, Hellblade takes a more interactive approach with sound. A common symptom of psychosis is the McGurk effect (Ninja Theory, 2017) [13] which is where sounds will morph depending on the visuals. This concept conveys how dynamic the sound design is, creating flow and a pleasant experience psychologically; In comparison to Perception, which uses a static environment of objects that make a sound when interacted with.

For a better binaural experience, Hellblade fails to convey elevation through the way the sound is projected to the user. The user could have an output through a spherical array of speakers, although this is not very cost efficient. A solution to this problem could be the utilization of Ambisonic headphones with B-format. 'B-format contains three channels for panto-phonic systems and a further channel for periphonic, i.e. with-height reproduction.' (Malham and Myatt, 1995) [15], this proposes that height can be perceived with these further additions of channels, in comparison to a stereophonic mix, containing only two.

3.3 Uncharted 4 (2016)

Uncharted 4 by Naughty Dog (Uncharted on PlayStation 4 – Naughty Dog, 2016) [16] is an action-adventure game that follows the story of 'Nathan Drake' (main protagonist), released on the 10th May 2016. With collaborative efforts with PlayStation 4 (PlayStation, 2018) [17], Naughty Dog have designed a world in which sound can be detected from all elevations in 3D space. (See Figure 4.)

Figure 4. Uncharted 4 (PlayStation™Store, 2018)

The Platinum Wireless Headset (PlayStation Europe, 2016) supports compatibility for 3D audio on PlayStation consoles, Uncharted 4 being the first to use this technology in its game. This achieves 7.1 surround sound, which entails 6 speaker positions, however the it is not possible to convey elevation with speakers unless placed below and above the player. The headset uses 7 audio channels to allow for spherical 3D spatial audio. Binaural audio is very limited at runtime due to its pre-recorded data, Uncharted 4 utilizes spatial audio through game engines and output devices instead. Horizon Until Dawn (Guerilla Games, 2017) [19] is another example of the use of The Platinum Wireless Headset and develops a psychological response for the player to pinpoint the enemy without the need of looking. This proves that there are significant improvements of awareness from players when the senses of sound are refined in a virtual world, and therefore it is plausible that other senses could enhance the player experience and immersion in future work, such as smell or even touch.

3.4 Summary

The success of Perception, and other horrors alike is due to how it can promote a psychological response that causes fear. A response like this can be created using different intensities and a small proximity to the player, which is an opportunity to take into consideration in future work as it adds a unique immersive experience, that engages the player into the flow of the game.

3D spatial sounds also improve the player awareness of their surroundings in the virtual world, and therefore increase playability, for example; Uncharted 4's utilization of 3D sound to portray elevation in scenes. For an experience a player can connect with, elevation can envelope the player with sound and immerse them completely.

However, Binaural Audio and 3D spatial sound is not excessively used in video games due to its secondary status, below visuals. There is a possibility to branch into 3D sound and revolutionize the industry, to place sound on par with visuals. A limitation of Binaural Audio is that it is created through pre-recorded sounds using Binaural recording devices. Thereby, the sounds are limited to change when placed in the game environment. As cutscenes are static events, in the sense that they do not change, binaural audio would be suitable for these parts of the game, as the sounds for these could be directed separately.

Spatial audio also requires the player to possess a headset with Ambisonics functionality or a 7.1 surround sound system; if they do not then the intended effect will be lost, as well as the immersion and gameplay functionality (such as the Sound HUD in Hellblade). In retrospect of this analysis, the success of Hellblade was significant, as Binaural recordings had never been used prior to this in such depth for games. Additionally, spatial sound in Uncharted 4 and Perception play a key role for an immersive environment that supports gameplay and story.

3.5 USP

Reflecting on ratings, 'Perception' faltered slightly on its delivery with a 56% score on Metacritic (Metacritic, 2018) [25] and a rating of 7/10 on Steam (Perception, 2017). The concept was unique and captivating, the desensitization of visual sensory input presented an engaging obstacle for the player to overcome, however more focus on sound would have benefitted for an immersive experience. This new understanding of visualization of sound through echolocation could be innovated into a game refined with better 3D spatial audio techniques, such as binaural recordings.

Hellblade was successful, being nominated for many awards and accolades, surpassing 500,000 sales in 3 months since launch (Eurogamer.net, 2018) [24]. The Unique Selling Point (USP) that attracted such a large audience was due to its take on Binaural recordings and techniques that improved the immersive experience for the player. The voices in Senua's head are haunting, and the game world around Senua breathes with her. This will inform 'Dumb Duck Studios' audio choices when in future developments, however Binaural recording devices are of great expense, so for an average Indie development team, using a set of two microphones would be proficient in recording binaural audio.

Lastly, Uncharted 4's (Metacritic, 2018) success was not entirely under the influence of sound, as it is the fourth in its franchise. The game already has a player base and the 3D sound can be toggled in the settings. However, its use in sound reinforces the ideology that sound should be sourced from 3 dimensions, a spherical auditory system to enhance gameplay and immerse the character in the world.

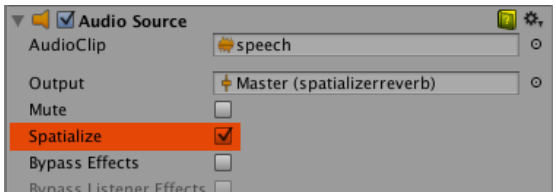
3.6 Technologies/Approach

3.6.1 Spatial Sound – HRTF, Ambisonics

Head Related Transfer Function is a way to compile directional sound so that direction and intensity can be determined, as suggested by (Lundqvist, 2010) [27],

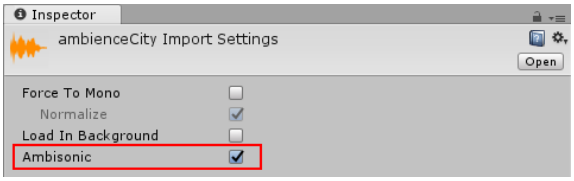
'Measurements of phase intensity and time difference is gathered and compiled to transfer functions'. Unity3D (Unity, 2018) [28] has an extension of the native audio plugin named 'Audio Spatializer SDK' (See Figure 5.) which will in-turn regulate intensity depending on the angle of the AudioListener to the AudioSource. This will inform the process of spatializing sound in a Unity 3D engine environment.

Figure 5. Unity Source Spatialize (HRTF) (Technologies, 2018) [29]



Unity Ambisonics Audio (Technologies, 2018) [30] is also part of the Unity engine and describes how the Ambisonics are stored in multiple channels instead of being mapped to specific speakers. This allows for a 360-degree rotation of sound, which could go hand-in-hand with spatializing to generate quality ambience. (See Figure 6.)

Figure 6. Unity Ambisonics Audio (Technologies, 2018) [30]



4. CONCLUSIONS

It is possible as an Indie developer to produce Binaural audio with Ambisonics to induce the immersive experience, and tackle a psychological response from the player, however to achieve audio on par with Hellblade, requires time, money and workforce. Unity provides a suite of simple spatial audio techniques, however Binaural recordings with expensive, high-end devices would be required for a AAA standard game. Spatial sound, if implemented correctly can be the reason for great success in a game, sound is no longer the secondary-role in comparison to visuals, rather it plays an equal part in the immersion, story, gameplay and mechanics.

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