GAME SOUND – WHAT DO WE GAIN?

Thomas Connell
Australian National University
School of Music

ABSTRACT

Many sounds can happen at any moment in a video game. How can one begin to analyse the soundscape when there are so many individual components? This paper establishes a set of categories of sounds based on the information that they give to a player. Drawing on the ideas of Schaeffer (1966) and Kane (2014), this system of categories is a flexible way to assess the soundscape of a game, informing additional collaboration between sound designers and developers who normally do not share a technical vocabulary.

This paper fills gaps in the academic discourse of music in video games as there has been little discussion on the use of sound design in the Ludomusicology literature. The proposed model takes a more holistic approach to sound design in games, and case studies of *Overwatch* (Blizzard Entertainment 2016) and *Super Mario Bros.* (Nintendo 1985) show how this system can be applied to the field of Ludomusicology.

1. INTRODUCTION

In my experience of creating game soundscapes, I found it difficult to find ways to articulate why I was placing sounds into the game. I found that there was no adequate terminology that I could use to reflect upon my creative practice. To create a technical framework that could be useful not just to myself, but to the wider field of Ludomusicology, I had to find ways to classify sounds. I began by asking the question: What information does a player actually receive from a sound event? With this as a basis, I considered sounds not by content, but by purpose. This required me to consider the nature of sound in video games and how sound can be used for the benefit or detriment of a player.

2. BACKGROUND

The soundscapes of today's games are very different from those in early video games. Employing only synthesised sounds comprised of simple waveforms, *Pong* (Atari 1972) uses a total of three sounds and no musical track. Belinkie (1999) acknowledges this limitation by noting: "Back in the early days, video game music was defined by its limits." (Belinkie 1999). In the present day, all gaming consoles have powerful processors, giving both the composer and the sound designer the ability to utilise hundreds or even thousands of sounds for both musical and sound effect purposes. With this freedom, the sonic environment of a game begins to resemble that of film, where music is made subservient to the image, and sound effects exist in either diegetic or non-diegetic formats.

This paper has roots within my own experiences as a composer and sound designer for a game which highlighted the lack of research and investigation into a certain aspect of Ludomusicological discussion. I soon realised, from discussions with game developers and education in middleware (software that controls a game's audio), that implementation of sound effects requires additional effort and attention. It also became apparent that the academic field of Ludomusicology lacked adequate resources on the purpose of sound effects.

In the process of scoring a game for colleagues at Queensland University of Technology, I discovered that I myself had to raise the topic of sound effects when discussing technical information, because music was their primary focus. I found myself with two co-dependent jobs; I had to generate sounds (including music) and then implement them into the game itself.

Much more of my time was devoted to implementing the sound effects for the game rather than the music. In the process of creating the sound effects, I had to take external field trips to record footsteps and voice actors and then edit the results. Creating this sonic material took far longer and required more activity than creating a sci-fi musical track for the game.

The academic field of Ludomusicology is still in its infancy and academics began to explore it only in the last two decades, starting with Belinkie's 1999 article. It is interesting to note how Belinkie's title contains a statement legitimizing the research and study of video game music. He begins with a discussion of the video game industry as a commercial entity, drawing attention to the profits that the industry made in the United States (in 1998) and noting that it may soon outstrip the revenue of the film industry. [1] Belinkie's emphasis on the commercial aspects of video games is important to justify this untapped research field and continues

[1] As of 2012, the video game industry made a total of $78.8 billion (US), not quite the $85 billion of the film industry (Marchand and Hennig-Thurau 2013).

justifying his research by discussing just how omnipresent video games at the time.

As Ludomusicology is recent, not a lot of people are engaged in the topic. That being said, some useful resources do exist like the *Society for the Study of Sound and Music in Games* (SSSMG). This society acts as a nexus for academic, professional and community groups of people who are working with video game audio ("About SSSMG" 2016).[2] The SSSMG, in its effort to act as a research hub, has gathered a bibliography of Ludomusicological research. This searchable bibliography is an excellent starting point for surveying the field as a whole.[3] The SSSMG bibliography, however useful it appears on the surface, mimics what can be seen in the professional and wider fields, a lack of discussion of the importance of sound effects. The Society's bibliography contains a total of 323 entries, including papers, articles, book chapters, and dissertations, all with keywords. These keywords can be used to demonstrate the lack of attention given to sound effects. Out of the total 323 resources, only 11 contain the keyword *sound effects* (3.4%). This is compared to 252 entries (78%) when *music* is used as a keyword. It could be said that the keyword music is a far more general term than sound effects, but it is still worth considering that many of the resources listed in the SSSMG's bibliography do not even touch on sound effects, and a number of those listed with the keyword *sound effects* do not actually contain many references to them. Even key phrases such as the *history of sound and music* and the *psychological effects of sound/music* in games appear more often than the keywords *sound effects* at 33 (10.2%) and 18 (5.57%) respectively.[4]

Although overall a small proportion of the Society's bibliography, some of the most useful information regarding sound effects has come from resources that take a more psychological approach. These resources highlight that sound effects are an important aspect of any video game experience and essential to a player's understanding of and immersion in the videogame world. Grimshaw, Tan and Lipscomb (2013) point to a number of studies that conclude that sound is one of the most important aspects of a game. "In particular, the category of 'realistic sound effects' was rated as 'very important' or 'extremely important' to the enjoyment of a game…"(Grimshaw, Tan and Lipscomb 2013). If players put so much emphasis on sound effects, why has the academic field ignored them to such an extent?

This perspective remains useful in discussing what kinds of sounds are actually important to the player and how the player processes and understands these sounds. The authors mention 'seductive details', an important concept that is briefly discussed, leading into commentary about the listening process (Grimshaw, Tan and Lipscomb 2013). Here, the work of Pierre Schaeffer (1966) and Brain Kane (2014) becomes relevant. Kane builds on the work in acousmatic theory and the concept of "music concrète" established by Schaeffer. Kane, in particular, has been an important research starting point for this project. The acousmatic experience has wider applications than just in Ludomusicological study, including how sound effects are perceived by a listener. It is important to consider just how the player associates sounds with object sources automatically, in a sort of reverse acousmatic experience.

The professional field of sound designers also notes the important psychological aspect to video game sound. The makers of *Wwise*, Audiokinetic, run a blog where they post advice. One post in particular references this psychological approach, discussing how sound affects the performance of players. They reference a number of studies about player performance, pointing out that reaction time is faster when using an audio cue rather than a visual one (Coen 2018). They also reference the Yerkes-Dodson Law (Yerkes and Dodson 1908), which states that player performance is a bell curve where an optimal point exists as a balance between low and high arousal (see Figure 1). This law will be discussed later in case studies to demonstrate how the proposed theoretical framework of this paper can be applied.

Figure 1. The Yerkes-Dodson Law.[5]

Game studies have also been another useful facet to this project. Phillips (2018) study of video game rewards is useful in terms of identifying sounds used as rewards. It is interesting to note in the emerging field of game studies, Phillips is also discussing theories based in a psychological approach to

[2] https://www.sssmg.org/wp/about-sssmg/.
[3] Including Grimshaw, Tan and Lipscomb 2013 and Kamp, Summers and Sweeney, 2016
[4] Other keywords include *sound* at 125 entries (38.7%) and *sound design* at 33 entries (10.2%).

[5] Image taken from https://blog.audiokinetic.com/player-success-how-to-help-or-hinder-it-with-sound/

rewards. Phillips also explores a more holistic approach to his research in a similar manner to that being undertaken in this paper.

Kristine Jørgensen (2010) debates the use of the terms Diegetic and Non-Diegetic and their relevance and use in the video game context. Jørgensen notes that the barriers between Diegetic and Non-Diegetic sound begin to breakdown inside games, where virtual characters may be speaking to the player directly (Jørgensen 2010). Jørgensen also references a system of categorization by Stockburger, whose system highlights how sound serves a functional purpose, but clearly links sounds to their sources, preventing any kind of flexibility within the system (Jørgensen 2010).

Questions about why the academic field of Ludomusicology has ignored sound effects up until this point remain, but this paper, in the same vein as Belinkie, attempts to shift the focus onto the wide variety of sound effects and their applications in a more holistic fashion.

3. CATEGORISING GAME SOUND

The amount of sonic content that could appear in a game presents significant challenges for analysis. It becomes important to investigate how the player interacts with these sounds and what purposes they serve. It is proposed that all sounds within video games can fall into one or more of five categories. These proposed categories are flexible, and a sound can fall within one category in one context and behave like another in slightly different circumstances. The sonic content may be the same, but additional information can be gained and lost through this transformation process. These categories exist on a "Scale of Realism" (see Figure 1), where lower numbered categories create a sonic environment that would exist in real life and upper categories provide increasingly abstract sonic and musical information to a player.

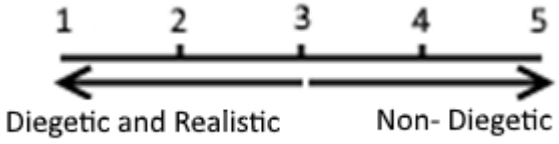

Figure 2. Scale of Realistic Sonic Behaviour.

The numbering of each category relates to its position on the "Scale of Realism". They are constructed in such a way that the lower categories (One and Two) are sounds that could be heard in a similar position in realistic terms and behave the same way. The higher categories (Four and Five) are associated with the musical soundtrack of a game; these sounds are not heard in everyday life.

Number	Name	Summary
1	Seductive Sounds	Associated with the Player and their actions.
2	External Sounds	Associated with Non-Players or external actors.
3	Sourceless Sounds	Sounds without an associated visual cue.
4	Emotive Elements	Emotional information from the soundtrack.
5	Musical Elements	Specific musical information from the soundtrack.

Table 1. Summary of the Five Categories

A number of questions must be answered to classify a sound into a specific category. The chart shown in Figure 3. illustrates typical questions that would be asked of each sound. These questions arise out of an autoethnographical approach that considers the different uses of sounds in varying contexts in the author's experience. The chart, however, shows only "pure" categories and does not take into account the flexibility of sound to be categorised at multiple positions on the scale. A future research task would be to identify all possible variations and expand this initial chart into a more comprehensive web.

3.1. Seductive Sounds

Category One sounds are designated as *Seductive Sounds* and are sounds provided with a corresponding visual cue that happens within the game. This name originates from "seductive details" as described by Garner, Brown, Sanders and Menke (1992). These sounds deepen the player's connection with the game and are the most common kinds of sounds. These may include footsteps, jumping noises or the vocalisations of the player's character. *Seductive Sounds* are associated with the player's actions, movements, and interactions. These sounds are common because the player needs to be able to interact convincingly with the synthesized environment. This interaction is common in both video games and film, where Foley artists create sounds that would be interpreted as a specific (and sometimes different from the original sound) interaction by the audience.

Seductive Sounds are associated with an action that the player undertakes. The goal of these cues is to replicate interactions that might be experienced in real life.[6]

[6] Listening Example: *Super Mario Bros.,* Nintendo, 1985, https://youtu.be/ia8bhFoqkVE 0:00-1:03

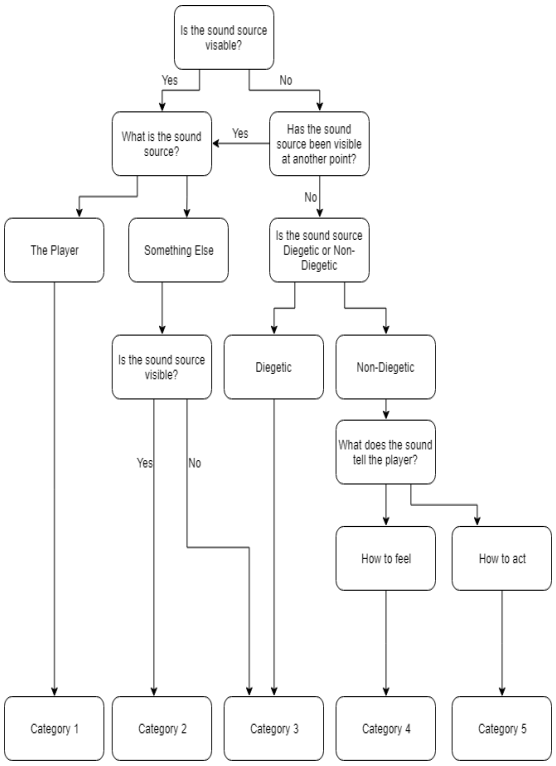

Figure 3. Flow Chart of Classification Questions.

3.2. External Sounds

Category Two, or *External Sounds* are sounds that are presented with additional visual information, and convey something extra to the player. These sounds are focused around additional characters or even other players (in examples such as Massively Multiplayer Online or MMOs). These sound cues include material that may be almost identical to sounds in the previous category, but instead they are centred around another character. For example, the player's avatar may share the same footstep noises as a non-player character (NPC), but the NPC's noises are playing a critical role in establishing the world revolving around the player. By moving these kinds of sounds relative to the player, a three dimensional sound world is created, which can be further modified by techniques such as occlusion, where sounds are muffled when the source is behind something such as a wall or hedge.

Dialogue is a key type of sound that falls within this category. Hearing the dialogue provides important clues to the character's emotional content, voice, and other non-linguistic information, which may not entirely come across through the written subtitles. Additional non-linguistic information extends to the kind of space the characters are in, by the use of effects such as reverb.[7]

[7] Listening Example: *Dragon Age II* , BioWare, 2011, https://youtu.be/J5oQQDuN_CY 0:00-0:39

3.3. Sourceless Sounds

Category Three, or *Sourceless Sounds* are named for the work of Schaeffer (1966) and Kane (2014), referring to these sounds lack of visible source. These sounds are presented without any other visual information on screen. All the information that the player receives from these sounds comes entirely from the sound itself. Pure *Sourceless Sounds*, that is to say sounds that only fall within this category, are less common than other categories and this category is perhaps one of the most flexible. Sounds can fall within this category when the player isn't directly looking at the source of the sound. An example of this type of sound is rain hitting a house's roof while the player is inside and not looking out the window. Should the character see the rain hitting the window (and thus see the sound's source), it would then be a category two sound, but without the window to confirm the sound source, the unknown source is automatically assigned to something familiar in order to avoid the acousmatic experience as mentioned earlier (Kane 2014).[8]

3.4. Emotive Elements

Emotive Elements that make up *Category Four* are some of the most important sound elements in games. *Emotive Elements* provide a special kind of information to the player through a crucial source that has not been discussed in the preceding categories, the music. *Emotive Elements* are the most commercial of the categories through soundtrack sales, and the most memorable component of sound design. This emotive information is presented in a way that has parallels to how music is used in film. Previous categories have focused on recreating a sonic environment that the player would experience in real life, whereas sounds that are classified as emotive elements are focused on more abstract emotional information. The composer is important in achieving effective communication of *Emotive Elements*; the design of the score is critical to its successfulness as a component of the game. The more effective a communicator of emotive information the more memorable the soundtrack is, which can then influence its commercial success as a standalone entity.[9]

3.5. Musical Elements

The last kind of sound cues are *Musical Elements* which are described by *Category Five*. This category exists to accommodate games such as *Guitar Hero* (RedOctane, Harmonix 2005) in which gameplay revolves around the music itself. *Musical Elements* are sounds that give the player specific musical

[8] Listening Example: Hellblade: Senua's Sacrifice, Ninja Theory, 2017, https://youtu.be/mJkDaqYdi70?t=1m56s 1:56-2:45

[9] Listening Example: *The Elder Scrolls V: Skyrim*, 2011, Bethesda Softworks. https://youtu.be/237X-cuGkJU 0:00-0:14

information that relates to the gameplay. In many cases it involves rhythmic information about the pulse and meter of a song. Games with these kinds of sounds often take pre-existing music and then apply their various mechanics to them in order to create a game.[10] These types of games are all associated with an aspect of music and are tied together with music as a thematic idea. Some games do exist that use this rhythmic mechanic outside of a game tied to musical themes. *Mother 3* (Brownie Brown, HAL Laboratory 2006) utilises a combat mechanic where the player must attack in time with musical beats to perform combos.

Although there are examples of *Musical Elements* in non-music themed games, they are few and far between. Some games do exist however that blend the boundary between musical game and other genres such as *Crypt of the Necrodancer* (Brace Yourself Games 2015), a dungeon crawler where the player must move in time with the music in order to explore and fight monsters.[11]

4. CASE STUDIES

With this new set of terminology established, it is now possible to ask questions about game sound that were impossible to answer before. The following two case studies show how these categories can be useful in exploring how players begin to interact with virtual environments.

4.1. Overwatch (Blizzard Entertainment 2016)

The more information that appears on a screen, the more a player's brain must work to process it all. In a similar manner to the Yerkes-Dodson Law, there exists a sweet spot for an optimal amount of visual elements that make up a game. Too much and a player can experience visual overload where their performance decreases (Grimshaw, Tan and Lipscomb 2013). One way to combat this is through decreasing the amount of sound elements a player receives. This can be achieved via *ducking*, an audio technique where sounds that are not as important to a player at one time are reduced or suppressed.

Overwatch utilises this ducking technique to allow a player to focus on what is important to them at the time, reducing the volume of other sounds accordingly. During an *Overwatch* game, two teams of six may be engaged in combat with each of the twelve players creating a large number of sound events, including gunshots, explosions, lasers and vocalisations. This results in a huge number of individual sounds which, if all presented at full volume with the visual information on screen the player's overall performance may suffer from cognitive overload. To combat this, Blizzard's sound designers (utilising Audiokinetic's *Wwise* engine) implement a complex form of ducking and attenuation to reduce the overall sonic information that a player may receive at any one time. Firstly, the further away a sound source is (like a character on the other side of the game arena), the more reduced the sound emanating from them is. This mimics the behaviour of sound in real life and would be an *External Sound*, as the source is a non-player. This attenuation is combined with ducking, which is based on what the player is looking at. For example, two long ranged sniper characters could be duelling across the field of play. Since the focus of the player's attention is the other sniper the sounds emanating from their allies around them will be reduced, whilst the sounds from the other sniper will be increased. This sonic behaviour is something that could not occur in reality but is useful to allow a player to focus their attention more sharply on their current task.

The sounds that are manipulated in *Overwatch* generally fall into the category of *External Sounds*. *Overwatch* is a player versus player (PvP) game where teams of players duel each other rather than the computer. It can be concluded that *External Sounds* are one of, if not the most important kind of sound needed for a player to be able to interact with the game world. Through subtle manipulation of these kinds of sounds, a player's performance can be enhanced or even negatively affected by controlling the level of cognitive load they are receiving.[12]

4.2. Super Mario Bros. (Nintendo 1985)

By using this system of categories, one can begin to explore questions such as: what sounds are required at a minimum for a player to be able to interact convincingly with a game? Looking at a game for a console with limited processing power can shed light on this question. The use of sound design at its most restricted can strip back much of what Grimshaw, Tan and Lipscomb (2013) refer to as "seductive details" which is evident in Nintendo's Super Mario Bros. (1985). This cuts to the core of the purpose of sound design. Taking an example of gameplay from Super Mario Bros.13one of the first things to notice is the use of music in the game. Koji Kondo's famous score is one of the most well known examples of music from video games and according to Belinkie, 66% of college students know and can

[10] Such games include: *Guitar Hero* (RedOctane, Harmonix 2005), *Singstar* (London Studio 2004), *Audiosurf* (Invisible Handlebar 2008) and *Crypt of the Necrodancer* (Brace Yourself Games 2015)

[11] Listening Example: *Crypt of the Necrodancer*, 2015, Brace Yourself Games. https://youtu.be/TOcBdl1elTc?t=1m25s 0:25-2:00

[12] Example of Overwatch gameplay: https://www.youtube.com/watch?v=ja88SUm3bLs

[13] This Case study discusses the following video: https://www.youtube.com/watch?v=ia8bhFoqkVE (0:00 - 1:04)

reproduce the melody even without having played the game for years (Belinkie 1999). This tune is very important to the overall experience of the game as it is the first thing you hear when the game starts (notice the lack of sound in the main menu and level loading screen). Overall, in this short snippet of game play, there exists a total of 60 sound events which can be assigned as seen in Table 2.

Distribution of Sounds in *Super Mario Bros.*		
Category	Count	Percentage
1	56	93.3
2	0	0.0
3	2	3.3
4	2	3.3
5	0	0.0
Total	60	100

Table 2. Table of sound cues in Nintendo's *Super Mario Bros.* 1985.

A large quantity of sounds are devoted to how the player interacts with the world. These *seductive sounds* are important because they mimic the function of sound in real life. It does not matter that these sounds are synthesized and if someone jumped in real life it wouldn't sound the same as Mario, it is the role that these sounds play that is important. The commonality being that a sound happens in reality when a person jumps (shoes scraping on the ground, air rushing past the ears and perhaps a vocalisation); and Mario's non-realistic jump sound. There are plenty more *Seductive Sounds* that occur in this short excerpt, including coin pickups, Mario shooting fireballs and jumping on the head of the Goombas.[14] This last one in particular, is a *Seductive Sound* as the sound is coming from Mario's interaction with the enemies, and by extension that is to say the player's interaction with the environment. If the sound could be determined to be originating from the Goombas rather than Mario, it could be an *External Sound*. Due to this ambiguity of origin, it would be prudent to examine how the sound relates to the player's actions. The sound of Mario hitting the boxes as well, is also a *Seductive Sound* as the player is the one to break the box, not an external actor.

Sourceless Sounds and *Emotive Elements* are both moving into the realm of more musical and non-realistic sounds and there are only a few of each in this example. *Sourceless Sounds* are concerned with temporary boosts and upgrades to the player's abilities whereas *Emotive Elements* are related to changes in the soundtrack. The most prominent and famous example of this is when Mario picks up the *Invincibility Star*. This upgrade gives Mario the ability to kill any enemy that he touches whilst making himself invulnerable. This power-up reoccurs often in the franchise and is almost always accompanied by the distinctive change in the soundtrack. Although the sound of the star occurs with a flashing effect that appears on Mario's avatar, this change in sound is far more obvious, allowing the player to quickly dash through groups of foes towards their goal.

Super Mario Bros. does not contain any sonic information relayed through any *Musical Elements*. As referred to above as *Musical Elements* rarely occur outside of musical related games and since Mario does not have any such relation the presence of *Musical Elements* would be highly unorthodox.

It is also important to note the use of reward based sound events, including picking up coins and the important sound at 1:03 where Mario finishes the level by sliding down the flagpole. Here the triumphant music signals the end of the level and the totalling of the amount of points earned from the remaining time (Phillips 2018). There are a number of rewards to congratulate the player for their actions and this has a greater effect on the player when the reward is accompanied by sensory feedback such as a sound effect (Phillips 2018).

By examining the distribution of sounds into the five categories some light is shed on what professional sound designers find appropriate to populate their soundscapes. Working within the limitations of the technology, sounds must have been chosen carefully and with thought. Additional sounds that do not provide key interactions must by necessity be left out. Therefore, it can be said that the most important sound design component for a game is how the player interacts with the world. Without this interaction it would be a very strange experience to play *Super Mario Bros.*.

5. CONCLUSION

I believe that there are many varied and interesting applications for the research outcomes from this project. Firstly I believe it would be interesting to see the outcomes of a process where the sound designer is a key member of the game development team. *Hellblade: Senua's Sacrifice* (NinjaTheory 2017) is an exemplar of the interesting approaches to sound design when the sound designers and audio technicians are included in the game design process.[15] It would also be interesting to complete a quantitative study of the use of sounds in such genres as: famous/popular games, games with large

[14] A Goomba is a recurring enemy in the Mario franchise.

[15] Hellblade: Senua's Sacrifice |Dev Diary 27| Senua's Soundscape https://www.youtube.com/watch?time_continue=5&v=5-D57571odo

budgets, retro games and indie games. It too would be prudent to expand on the material in Figure 3, and create a more complex web, able to take into account the flexibility of this proposed system.

Working together, these categories explore the relationship between the players and the sonic environment within a game. These categories also equip the field of Ludomusicology with a set of tools capable of discussing and analysing sonic environments. This last point in particular is important due to the apparent neglect of sound effects from the field. It is hoped that this paper will spawn a further discourse of sound effects, reflecting their importance inside games and eventually leading to a more creative use of sound effects.

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