Emphatic and Ecological Sounds in Gameworld Interfaces

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Game sound has come a long way since the characteristic feedback sounds of jumping in *Super Mario Bros*. (Nintendo, 1984) and the chase music of *Pacman* (Namco, 1980). Today, game sound has the same quality as high production Hollywood sound, and it may also seem to fulfill the same functions. Game sound follows dramatic progress and accompanies events and player actions. As games are interactive by nature, one cannot create a defined, linear soundtrack like the soundtracks of traditional films. Instead, sound must be dynamic (Collins 2008: 3) by adapting to particular game actions and events as they happen. Having integrated this kind of dynamic sound system into a game, developers can also use the sound not only as response to player actions; it may also be used to provide the player with hints and warnings that affect their interaction with the game and movement through the gameworld.

Game sound affects the player directly, and the player may engage in the production of sound in the game. This puts game sound in a particular position. It is part of an environment that does not only feel like a living environment—it can also be interacted with as a living environment. Sound gives the player in-depth understanding of the gameworld as a living ecosystem, and provides information with direct impact on the players' choice of actions and their playstyle. Although sound helps give the pixels a sense of physicality in all kinds of games (Jørgensen 2007a: 85, 141), the way that sound supports interaction and a sense of place is particularly important in games that feature a gameworld. Such games are the focus of this chapter. Stressing the gameworld as an eco-system, this chapter will discuss the weaknesses and strengths of the concepts and theories that are commonly used to understand

game sound, and present a gameplay-sensitive, ecological perspective based on the idea of *gameworld interfaces* (Jørgensen 2013). The aim is to provide a medium-specific understanding of sound in games that will expand the understanding of screen music in the digital age to also include music not only in interactive, but also in ludic contexts.

Background

Attention towards the academic study of game sound started around 2000, and a few exploratory papers were published that took a historical view on game sound technology and interactive audio (Collins 2004; Weske 2000), on music in games (Pidkameny 2002; Whalen 2004), and on the relationship between sound and the game environment (Stockburger 2003). Also, a few handbooks on how to develop game audio were published in the same period (Marks 2001; Sanger 2003). In 2007 the first dedicated PhD dissertations on game sound were defended (Grimshaw 2007; Jørgensen 2007a), and the first academic monograph in the field was published shortly after (Collins 2008).

Today, research on game sound is multidisciplinary and often also trans-disciplinary, covering and combining perspectives from technical sciences, human sciences, social sciences, and psychology. While there is a growing body of research on game sound, this is still an understudied area within the expanding field of game studies. Researchers are still searching for a comprehensive theory of game sound, combining relevant theories from fields such as psychoacoustics, cognitive theory, music theory, film sound theory, and the field of auditory displays with empirical data on games and players. Some research takes a practical and applied perspective in which the focus is on technical development (Bridgett 2008; Paul 2008; Murphy and Neff 2011; Holtar et al 2013), new techniques for implementing game sound (Böttcher 2013; Böttcher and Serafin 2014; Collins 2009; Hoeberechts et al 2014), or game sound design (Stockburger 2004; Friberg and Gärdenfors 2004; Alves and Roque 2011).

Other research focuses on the player experiences, for instance by looking at how game sound provides information to the player (Jørgensen 2007, 2009), and the psychological mechanisms at play (Collins 2013; Ekman 2005; Garner 2013; Grimshaw and Garner 2014; Toprac and Abdel-Megruid 2011). In this research, both qualitative and quantitative methods have been used, from ethnography to experiments. Also, the aesthetic perspective on game sound is central in much research (Bessel 2002; Whalen 2004; Breinbjerg 2005). While the research has been sensitive towards the interactive nature of game audio, little research stresses what interactive audio means for the aesthetic appreciation of games and the understanding of games as a medium. This chapter aims to do this through a focus on the idea of the gameworld as a world environment designed for play.

A medium-specific perspective on game sound

While a paradigm has not yet been established in game sound research, some recurring perspectives may be highlighted. Game sound researchers tend to agree on the importance of a medium-sensitive understanding of game sound. It is understood as fundamentally different from film sound, and must be viewed in the context of the game and gameplay—a critical perspective in game sound research (Collins et al 2014: 4). While game sound draws on conventions of cinema, analyzing and evaluating it as such risks ignoring the particularities of game sound. The interactive component of games asks for perspectives that are able to take into account the fact that gameplay happens inside a simulated environment that responds to the player's actions.

Game sound has a dynamic quality in that it responds to events in the game environment, including actions taken by the player. According to Karen Collins, *interactive sound* occurs in response to player actions, such as gunshots or footsteps created by the player. *Adaptive sound*, on the other hand, responds to changes in the game state, such as the

player gaining or losing health, receiving power-ups, etc. (Collins 2008: 3). This perspective pays attention to the fact that sound does not only have atmospheric and dramatic purposes, but has a clear function with respect to providing the player with information relevant to their actions. Included for a variety of informative purposes, game sound may therefore be considered a kind of *auditory display* (Jørgensen 2007: 71, 2009: 92–93), defined as "the use of any type of sound to present information to a listener," (Walker and Kramer 2004: 151) such as alarms and warnings. Although auditory display theory concerns the natural environment, the theory is indeed applicable to games; however, it is not specific enough to take into consideration the game context, the dynamics that come into being when the players interact with the game mechanisms, and the fact that games sometimes have unnecessary obstacles for the sake of challenge.

Although game sound is dynamic, there are still similarities with film sound. Featuring expansive audiovisual worlds, games are not unexpectedly also borrowing conventions from film sound. In both media, sound is an important source of information for both the audience and characters, and sound plays an important role in creating drama and atmosphere. Also, both media are often described as having different levels of information from which sound can emerge.

Film theory broadly defines sound unheard by the characters and thus considered non-existent in the storyworld *non-diegetic* sound, which is contrasted with *diegetic* sound produced inside the storyworld that the fictional characters are, for this reason, able to hear (Bordwell 1986: 16; Bordwell and Thompson 1997: 92). This division has also become popular in game sound research (Collins 2008; Grimshaw and Schott 2007; Huiberts and van Tol 2008; Jørgensen 2007b; Stockburger 2003; Whalen 2004). This strict division between what exists "inside" or "outside" the storyworld has, however, been contested in film theory (Gorbman 1987, 22–23; Kassabian 2001, 42; Smith 2009; Stilwell 2007; Winters 2010) as

well and in game studies (Ekman 2005; Grimshaw 2008; Jørgensen 2011). For both films and games, it is argued that sound often takes up the liminal position in between clearly defined boundaries, or that it may move from an external to an internal position or vice versa during the course of a scene or an event. Another recurring argument is that since films and games present fictional or artificial situations, neither is obligated to strive towards any idea of realism but is instead guided by its own internal logic which may or may not comply with a traditional idea of what counts as diegetic or non-diegetic. Based in such arguments, Stilwell argued that much film sound has a liminal quality that locates it in a "fantastical gap" (Stilwell 2007), while I argued that the interactive properties of games necessarily makes game sound *trans-diegetic* (Jørgensen 2007b).

However, the important difference is that player of games have agency on a radically different level than the film audience. When watching a film, the audience may use cues in the sound as an index of drama. In *Jaws* (dir. Steven Spielberg, 1975), for instance, the audience understands that the person swimming is the target of the shark based on the characteristic musical theme, but cannot do anything to hinder the impending disaster. In a game, however, such non-diegetic music signaling danger is information the player can act upon. In addition to having dramatic impact, game sound is designed to ease the player's interaction with the game. Thus, when the music changes from mellow to dramatic in *The Elder Scrolls 5: Skyrim* (Bethesda Game Studios, 2011), this is a signal to the player that the avatar should draw the sword and prepare for combat—or run for their lives (Jørgensen 2007: 105). Even in situations where non-diegetic sound addresses fictional characters, such as the voice-over narrator commenting on the protagonist's life in *Stranger than Fiction* (dir. Marc Forster, 2006) there is a fundamental difference between films and games in that although the character may act based on 'impossible' information in this film, the audience has no power to actually influence the events on screen based on auditory information.

Because of the participatory element of game sound, many game scholars agree that adapting the terms diegetic and non-diegetic to game sound is confusing (Collins 2008: 180; Jørgensen 2008: 125, 2011: 78–79). Indeed, these concepts were not created with games in mind, and do not take into account the fact that gameworlds are dynamic and do not behave like the pre-planned storyworlds that are designed with a particular dramaturgy in mind. However, being easy to understand and simple to use the terms still have merit for making broad statements about sound in games, and as this discussion shows, they are also fruitful for comparative purposes.

However, an alternative way of thinking about game sound has gained foothold in game studies. Attention has been given to the fact that in most desktop and console-based games, players engage with sound in the context of a gameworld environment. For this reason, the spatial aspect is important for game sound. Mark Grimshaw is a proponent of an ecological perspective of game sound, stressing that game sound is an index of the interactions that happen in the environment, constantly responding to the player's actions, and signaling what happens elsewhere that may be of consequence for the player (Grimshaw 2008). This ecologically-oriented perspective has opened up a holistic way of viewing game sound that includes seeing games as environments in which sound plays a role not very different from that in the physical world. In order not to reduce real-world interaction with game interaction, however, it is crucial to stress the particularities of gameworlds and game interaction when applying this perspective. In the following I will stress the fruitfulness of the ecological perspective when understanding game sound.

An ecological perspective on game sound

The ecological perspective may help us understand how the use of game sound is different from other uses of sound, and take into account not only the interactive context, but also the

fact that the gameplay situation puts specific demands on the player that are not seen in other screen contexts. As mentioned above, it is common for many screen-based modern games to take place inside an environment that is built for the purpose of gameplay. In most modern screen-based game genres for console and PC, and also increasingly for handheld devices, these game environments are constructed as worlds—virtual places and simulated spaces that can be traversed, explored, and interacted with in different ways depending on the particular game. They are neither traditional fictional worlds, diegeses made for storytelling, nor simply virtual worlds. They are *gameworlds*—environments for play built around the logics of games. Gameworlds are arenas designed for participation and contest (Klevjer 2007: 58), and the guiding principles of how they function are game mechanics rather than traditional laws of physics (Jørgensen 2013: 56). Importantly, gameworlds are also world systems, representing a habitable and self-contained world-like environment (Bartle 2004: 1; Ryan 2001: 91). Gameworlds are dynamic environments in which the inhabitants have an impact on each other as well as on the environment, and where the environment has an impact on the inhabitants (Jørgensen 2013: 56)—they are *ecologies*. Ecologies are ecosystems that define the living conditions of organisms (Gibson 1979: 7–8), and from which the organism must draw information relevant for their behavior. In this sense, gameworlds are also informational systems where the ecology offers a number of signs that enable meaningful gameplay (Jørgensen 2013: 78). Sound plays an important role in constructing space and positioning the player inside that space (Collins 2013: 48).

Mark Grimshaw and Gareth Schott argue that an ecological perspective is essential when considering sound in first-person shooters, but the argument also holds true for all games that allow players to interact with a gameworld. Talking about *acoustic ecology* as an environment dominated by auditory information rather than as a field of study, they write:

> [T]he function and role of sound within FPS [first-person shooter] games is best expressed as an acoustic ecology in which the player is an integral and contributing

> component. In utilizing the term ecology, we therefore presuppose the notion that there is a web of interactions occurring at a sonic level. Indeed, the term is used to account for a space that is neither fixed nor static, but constantly changing as players respond to sounds from other players (or computer-generated characters) with their own actions, thereby contributing additional sounds to the acoustic ecology and potentially providing new meaning to, and eliciting further responses from, other players. It also accounts for other responsive relationships in which players respond to sounds produced by the game engine while the game engine itself produces sounds in response to player actions. Thus, all sound-producing game objects and events are perceived as contributing components to its acoustic ecology. (Grimshaw and Schott 2007: 475)

Grimshaw and Schott stress that game sound is important for comprehending the game environment as an ecology, because sound is an index of the interactions that happen in the environment—constantly responding to the player's actions—and also signaling what happens elsewhere that may be of consequence for the player. Following this, we may add that sound provides an additional dimension through which we can understand the environment. This additional dimension should not be understood as a supplement to the visual elements; rather, both auditory and visual elements are understood as sensory supplements to the actual physical or virtual reality.

So what does the ecological perspective mean for the integration and presentation of sound in games? It may seem that the obvious answer to this question is that game sound must be as similar as possible as corresponding sound in the physical world. There is indeed a trend among modern games towards what Jay David Bolter and Richard Grusin call *immediacy*: a style of representation that aims to "make the viewer forget the presence of a medium (….) and believe that he is in the presence of the objects of representation" (1999: 272–273). However, even in the physical world, natural sensory stimuli are not always enough. We augment our natural environments with visual signs such as traffic signs and informative boards, as well as alarms and recorded messages. Even though gameworlds are dynamic ecologies that respond to the player's presence, they cannot today provide more than auditory and visual feedback, and on consoles, vibration. Thus, in order to provide sufficient

relevant information in a gameplay context, gameworlds must in many cases go beyond a sense of realism. In other words, the fact that game sound provides information that supports the player's actions in the gameworld stresses the idea that certain types of game sound must be easily heard and recognizable. This exaggeration of features to make them more noticeable is what Bolter and Grusin call *hypermediacy*: a style of representation that aims to "remind the viewer of the medium" (1999: 272). Although it may not be seen as a trustworthy representation of how sound operates in the physical world, we accept that wolves in *World of Warcraft* (Blizzard Entertainment, 2004) growl when they are about to attack, because this provides relevant and important information for us as players. At the same time, however, the growl is recognizable as the sound of a wolf. It is a warning or notification to the player (Jørgensen 2007: 73, 2009: 95); game system information that eases interaction with the game while being masked as a sound produced from a source inside the gameworld (Ekman 2005).

This example shows how sound in games often tends to situate itself on the borderline: The growl has some properties that makes it recognizable to a sound we know from wolves in the physical world, but at the same time it occurs in a situation that does not correspond to the physical world: wolves would generally not warn their prey with a growl. Still, the sound is part of the gameworld ecology. The growl comes as a response to the player's proximity relative to the wolf (the player is inside the monster's aggression zone), and it provides information that impacts upon the player's actions (the player can stop and defend themselves, or try and get away).

Being designed for gameplay and ruled by game mechanics, gameworlds operate according to principles other than a strict sense of physical or audiovisual realism. This makes it possible for game designers to be flexible in the integration of features in gameworlds. Sound is a particularly powerful form of representation in that matter. Due to its temporal quality, and the fact that it is neither material nor visible, sound is an effective way of

communicating game information in an unremarkable, yet perceptible manner because it utilizes a different channel of perception and does not get into the way of visual attention (Jørgensen 2013: 41–42). Instead, the sound matched with a particular game event will be perceived as part of that event. In relation to film, Michel Chion calls this necessary perceptual merger that happens whenever an auditory and visual phenomenon occurs simultaneously *synchresis* (Chion 1994: 63). This does not mean that sound is subordinate to our visual perception, or that sound only receives meaning from simultaneous events. On the contrary, the merger between sound and image itself gives added value to the image; a new meaning comes into being that is caused not by the sound and image alone, but by the relationship between the two (Chion 1994: 5). In games, however, sound is *kinesonically syncretic*—it merges not with image, but action (Collins 2013: 32). Thus, sound never just reinforces what we see or do; in interpreting a particular event, sounds—like visual stimuli—integrate into the event itself and become a natural part of it. Sounds are never perceived as separate from their sources in our minds (Collins 2013: 23). When we hear a sound we do not think of it as an isolated sound, but part of an event that may also materialize in visual properties. In this context, sound, visuals, and action together form an informational whole that is greater than the sum of the stimuli itself.

Towards a framework

The perspective I have argued for above is not simply an ecological perspective. It is an ecological perspective that is sensitive towards the specific characteristics of the gameworlds, and how they are designed for specific play activities and governed by game mechanics. Sound is an important factor for the players' understanding of the gameworld ecology, and when making sense of how game sound works to do this, it is important to show how it integrates with the gameworld environment.

Frameworks to better understand game sound have been developed before. Grimshaw adapts and reframes the concept of *diegetic sound* into an ecological and game-specific terminology. In his new understanding, diegetic sound "emanates from the gameplay environment, object and characters" and must "derive from some entity of the game during play" (Grimshaw 2008: 24). In this sense, diegetic sounds do not have to be placed inside the game environment in a way that corresponds to the physical world, and sounds are diegetic as long as they relate to actions and events in the gameworld (Jørgensen 2011: 84). Based on this understanding Grimshaw introduces additional concepts that specify whether a sound is heard by specific a player (*ideo-diegetic* sounds), and whether a sound is the result from the player's input (*kine-diegetic* sounds) or not (*exo-diegetic* sounds). He also introduces *tele-diegetic* sounds produced by one player and with consequence for another player who does not hear the sound. Through a focus on how sounds produced by events in the gameworld relate to players' experiences and actions, Grimshaw stresses the ecological perspective. At the same time, his reframing of diegetic sound is radically different from the original understanding of the terms and is, for this reason, confusing (Jørgensen 2011: 85).

Another relevant framework that also attempts a game-centric understanding of game sound is Sander Huiberts' and Richard van Tol's *IEZA framework* (2008). Combining diegetic and non-diegetic sound with setting and activity, they identify four different categories of game sound: *Interface sounds* are non-diegetic sounds related to an activity, such as the sound of a mouse-click when selecting a particular action in the menu. *Effect sounds*, on the other hand, are diegetic sounds connected to an activity, such as the sound of a gunshot when pulling the trigger of the game controller. *Zone sounds* are diegetic sounds relating to the environment such as the sound of wind and rain. *Affect sounds* are non-diegetic sounds related to the environment, typically music that signals the start of a battle or entering a certain area in the game. This approach takes into account both the spatial aspects of game sound as well

as the interactive elements, and comes—for this reason—close to an ecological perspective, but does not take into account the fact that sometimes the categories glide into each other.

In my own research, I have outlined frameworks for understanding game sound from a functional perspective inspired by auditory display studies (Jørgensen 2007a: 64, 2009: 82), but in later work, I have also stressed the ecological perspective (Jørgensen 2011: 92–93). With the point of departure in my own research on gameworld interfaces (Jørgensen 2013) in combination with Grimshaw's ecological perspective and Collins' focus on interactive and adaptive sound, I will present a conceptual framework for understanding game sound inside the gameworld ecology.

A small disclaimer is, however, in place here. The ecological perspective I am about to present focuses on the complexities of game sound, how it is used, and what kind of information it provides about the gameworld environment. As we will see, there are many situations that render it unclear exactly how to categorize a particular sound. Thus, the purpose of presenting a framework is not to reduce this complexity, but to organize this complexity and show *how* game sound is 'trans-diegetic' rather than just concluding that it is. In this sense, the framework provides concepts to talk about the complexities of game sound, and may also be useful in teaching game sound design and analysis. Not least, adding a formalist approach to such a dynamic feature such as game sound is also an invitation to a kind of criticism that helps move our understanding of game sound, and hence also screen sound more broadly, onward.

Ecological and emphatic sounds

When making sense of game sound—how it relates to the gameworld and helps the player make sense of interacting with it—we must ask what status a certain sound has with respect to the gameworld ecology. With regards to game sounds that have an actual or potential impact

on gameplay, we can distinguish ecological and emphatic sounds. What I call *ecological sounds* are directly associated with the gameworld's ecology, and have a close verisimilitude to sounds in the physical world. This means that they are easily recognized as produced by a particular source inside the gameworld environment, and they are thus similar to what the field of auditory display calls *auditory icons* (Friberg and Gärdenfors 2004: 151; Gaver 1986; Jørgensen 2009: 84; Walker and Kramer 2004: 152). Unlike auditory icons, however, ecological sounds also have an impact on the gameworld; either because it provides the player with information that they may respond to, or because the player may impact upon the sound through engaging with the source in question. Ecological sounds can often be recognized as corresponding to natural sounds in the physical world, but since gameworlds often include magic or fantastical features, they may also include the sound of magical items or spells.

Ecological sounds can be contrasted with what I call *emphatic sounds*. They emphasize or augment an event in the gameworld, and provide additional information compared an ecological sound. Emphatic sounds are used in situations where ecological sounds do not communicate clearly enough, or when the player is not present at the same location as the event to which the sound refers. With regards to the use of signal, they are often *earcons*, that is, artificial noises or musical phrases (Friberg and Gärdenfors 2004: 151; Blattner et al 1989; Jørgensen 2009: 84; Walker and Kramer 2004: 152), but they can also be linguistic signs or stylized auditory icons. Emphatic sounds can be auditory augmentations with the purpose of attracting attention or giving clear feedback, such as verbal responses in *Diablo 3*'s (Blizzard Entertainment, 2012) "I cannot carry any more" or the use of enemy music; but also subtle sounds such as confirmation clicks when selecting an ability, item, or option may be considered emphatic sounds.

Rather than diegetic and non-diegetic, this division is better for games because it stresses the ecological and informative aspects of the gameworld over the dramatic and

narrative aspects that are central to classical diegeses. Also, the two categories are flexible enough to be combined with other dichotomies to highlight a range of interesting dimensions. One such dimension that reflects Collins' separation between interactive and adaptive sound, is to distinguish between *player generated* and *environment generated* sounds. This is relevant in order to know whether a sound represents a potential threat to the player or not, indicates whether a sound can be considered feedback to the player's own actions, or information about an event in the gameworld that might need the player's attention. Another relevant dimension adapted from my research on gameworld interfaces is whether a particular sound is *fictionally* or *ludically* motivated (Jørgensen 2013: 114, 148). If a sound is fictionally-motivated it is represented in a way that is in accordance with fictional coherence; that is, our ability to imagine the gameworld as a coherent fictional world (Juul 2005: 122–123). Fictionally motivated sounds can be explained as a natural part of the fictional reality, and often correspond, for this reason, to ecological sounds. If a sound is ludically motivated, on the other hand, it supports communication of game rules without being masked as part of the fiction. Sounds related to power-ups and achievements are typical examples of this.

Different kinds of ecological sound

Following the discussion above, ecological sound is sound that impacts the environment and its inhabitants. Such sound may be motivated by fictional or ludic coherence, and may be generated by player actions or by the game environment. This gives us the following types of ecological game sound:

When ecological sound is fictionally motivated, it is integrated into the gameworld ecology in a way motivated by fictional coherence. The sound of avatar's footsteps when running and jumping in *Assassin's Creed Syndicate* (Ubisoft Quebec, 2015) is an example of a player-generated fictionally motivated ecological sound. On the other hand, the sound made

by enemies such as the alien crawling around in the ventilation shafts in *Alien: Isolation* (Creative Assembly, 2014) is an example of an environment-generated sound of the same kind. Both sounds impact their surroundings, and adapt to fictional coherence, but the source of origin decides whether one works as feedback on its own actions, or a notification on events in the environment.

In contrast, when ecological sound is ludically-motivated, it is integrated into the gameworld ecology, but the manner of integration does not adhere to fictional coherence. Instead, it is motivated by the wish to clearly communicate gameplay mechanics or achieved goals. An illustrating example of a player-generated ludically-motivated ecological sound is found in the action role-playing game *Diablo 3* (Blizzard Entertainment, 2012). When the avatar claims "I can't use this yet" as they are trying to pick up an item, this provides information that the avatar does not have the sufficient level or skill to use that object. Since this has consequence both for the environment (other players can pick the item up) and for the player (who may be motivated to make room in the inventory), this sound is labeled ecological rather than emphatic. It is worth noticing, however, that the sound also has emphatic properties since it stresses the fact that the avatar discards rather than picks up the specific item.

An example of an environment-generated ludically motivated ecological sound is the earlier mentioned growl of an attacking wolf in *World of Warcraft* (Blizzard Entertainment, 2004). Since it is unlikely that a hostile animal would announce its attack, the sound breaks with what we would expect from a fictionally coherent world, and it has a ludic importance because it notifies the player about a change in game state. This specific example is interesting, though, because it is being *masked* as a fictional sound (Ekman 2005).

Different kinds of emphatic sound

As discussed, emphatic sound augments and provides additional information about events in the gameworld. Like ecological sounds, emphatic sounds may be motivated by fictional or ludic coherence, and may be player-generated, or environment-generated. This gives us the following four kinds of emphatic game sound:

When emphatic sound is fictionally-motivated, it adheres to fictional coherence, but is not part of the gameworld ecology. An example of a player-generated fictionally motivated emphatic sound is the sound played when manipulating the pip-boy interface attached to the avatar's wrist in *Fallout 3* (Bethesda Game Studios, 2008). The interface is represented as something that would exist in the fictional retro-futuristic universe of the game, but since it does not directly affect anything in the gameworld environment, it cannot be ecological. However, an environment-generated fictionally motivated emphatic sound would be a sound played on the pip-boy that signals events that take place in the gameworld. Whether this would make the sound ecological by influencing player action is, however, open to discussion.

When emphatic sound is ludically motivated, it does not make any attempt of conforming to fictional coherence, but stresses game goals or mechanisms. Most sounds that typically would be described as non-diegetic sounds are inside this group. Mouse-clicks when selecting abilities or items from an action bar in the real-time strategy game *Command & Conquer: Tiberium Wars* (EA Los Angeles, 2007) is a typical example of a player-generated ludically motivated emphatic sound. Music triggered by attacking enemies in the earlier mentioned *The Elder Scrolls 5: Skyrim* (Bethesda Game Studios, 2011) is an example of environment-generated ludically motivated emphatic sounds.

Summary

This chapter has presented central issues in game sound research with focus on a game-sensitive perspective that stresses the gameworld as an ecological world construct ruled by game mechanics and designed for gameplay. An ecological perspective is central not only for understanding how an individual player makes sense of game sound in a gameplay context, but may also be fruitfully applied to multiplayer scenarios online and for gameplay in shared physical space. With this perspective in mind, the chapter has outlined the most important recurring viewpoints and theories, discussed the strengths of an ecological perspective in understanding the dynamic aspects of game sound, and presented an analytical framework that reflects this perspective.

Since the ecological perspective highlights the gameworld as a dynamic environment meant for interaction, only sounds that support the player's engagement with the gameworld were discussed in the article. This does not, however, mean that such sounds are of no interest. As a matter of fact, research on how players distinguish between ornamental and functional sounds, and how atmospheric sounds affect the understanding of the gameworld ecology is an understudied area, and would be an interesting next step in game-sound research.

Further reading

Collins, K. (2008) *Game Sound. An Introduction to the History, Theory and Practice of Video Game Music and Sound Design*. Cambridge: MIT Press.

Grimshaw, M. (ed.) (2010) *Game Sound Technology and Player Interaction. Concepts and Developments*. Hershey: Information Science Reference.

References

Alves, V. and Roque, L. (2011) “Guidelines for Sound Design in Computer Games,” in M. Grimshaw (ed.) *Game Sound Technology and Player Interaction. Concepts and Developments*. Hershey: Information Science Reference, pp. 362–383.

Bartle, R. (2004) *Designing Virtual Worlds*, Indianapolis: New Riders.

Bessel, D. (2002) “What's That Funny Noise? An Examination of the Role of Music in Cool Boarders 2, Alien Trilogy and Medievil 2,” in G. King and T. Krzywinska (eds.) *Screenplay: Cinema/Videogames/Interfaces*. London and New York: Wallflower, pp. 136–144.

Blattner, M., Sumikawa, D. and Greenberg, R. (1989) “Earcons and icons: Their structure and common design principles,” *Human Computer Interaction* 4 (1): 11–44.

Bolter, J.D. and Grusin, R. (1999) *Remediation. Understanding New Media*. Cambridge: MIT Press.

Bordwell, D. and Thompson, K. (1997) *Film Art. An Introduction to Film Theory*. New York: MacGraw-Hill.

Bordwell, D. (1986) *Narration in the Fiction Film*. London: Routledge.

Böttcher, N. and Serafin, S. (2014) “A Review of Interactive Sound in Computer Games: Can Sound Affect the Motoric Behavior of a Player?” in K. Collins, B. Kapralos and H. Tessler (eds.) *The Oxford Handbook of Interactive Audio*. Oxford: Oxford University Press, pp. 443–456.

Böttcher, N. (2013) *Procedural audio for computer games with motion controllers: An evaluation of the sound design approach and possible effect on the user's motorical behavior*, PhD diss., University of Aalborg.

Breinbjerg, M. (2005) “The Aesthetic Experience of Sound: Staging of Auditory Spaces in 3D Computer Games,” *Proceedings of Aesthetics of Play Conference*, University of Bergen, Norway.

Bridgett, R. (2008) “Dynamic Range: Subtlety and Silence in Video Game Sound,” in K. Collins (ed.) *From Pac-Man to Pop Music. Interactive Audio in Games and New Media*. Aldershot: Ashgate, pp. 127–133.

Chion, M. (1994) *Audio-Vision. Sound on Screen*, ed. and trans. C. Gorbman, New York: Columbia University Press.

Collins, K., Tessler, H. and Kapralos, B. (2014) “Introduction,” in K. Collins, B. Kapralos and T. Holly (eds.): *The Oxford Handbook of Interactive Audio*. Oxford: Oxford University Press, pp. 1–14.

—— (2013) *Playing With Sound*. Cambridge: MIT Press.

—— (2009) “An Introduction to Procedural Audio in Video Games,” *Contemporary Music Review* 28(1): 5–15.

—— (2008) *Game Sound. An Introduction to the History, Theory and Practice of Video Game Music and Sound Design*. Cambridge: MIT Press.

—— (2004) “One Bit Wonders: Interactive Audio in the 8-bit Era,” *Proceedings of the International Association for the Study of Popular Music Canada Conference*, Ottawa.

Ekman, I. (2005) “Meaningful Noise: Understanding Sound Effects in Computer Games,” *Proceedings of Digital Arts and Culture Conference,* Copenhagen, Denmark.

Friberg, J. and Gärdenfors, D. (2004) “Audio Games: New Perspectives on Game Audio,” in the *Proceedings of the ACM SIGCHI International Conference on Advances in Computer Entertainment Technology,* Singapore.

Garner, T. (2013) *Game Sound from Behind the Sofa: An Exploration into the Fear Potential of Sound & Psychophysiological Approaches to Audio-centric, Adaptive Gameplay*, PhD diss., University of Aalborg.

Gaver, W. W. (1986) “Auditory icons: Using sound in computer interfaces,” *Human-Computer Interaction* 2: 167–177.

Gibson, J.J. (1979) *The Ecological Approach to Visual Perception*, Boston: Houghton Mifflin.

Gorbman, C. (1987) *Unheard Melodies. Narrative Film Music.* Bloomington, Indianapolis: Indiana University Press.

Grimshaw, M. and Garner, T. (2014) "Embodied Virtual Acoustic Ecologies of Computer Games," in K. Collins, B. Kapralos and H. Tessler (eds.) *The Oxford Handbook of Interactive Audio*. Oxford: Oxford University Press, pp. 181–195

—— (2008) *The Acoustic Ecology of the First-Person Shooter: The Player, Sound and Immersion in the First-Person Shooter Computer Game.* Saarbrücken: VDM Verlag.

—— (2007) *The Acoustic Ecology of the First-Person Shooter*. PhD dissertation. Hamilton: University of Waikato.

Grimshaw, M. and Schott, G. (2007) "Situating Gaming as a Sonic Experience: The acoustic ecology of First-Person Shooters," *Proceedings of DiGRA: Situated Play,* Tokyo, Japan.

Hoeberechts, M., Shantz, J. and Katchabaw, M. (2014) "Delivering Interactive Experiences through the Emotional Adaptation of Automatically Composed Music," in K. Collins, B. Kapralos and H. Tessler (eds.) *The Oxford Handbook of Interactive Audio*. Oxford: Oxford University Press, pp. 419–442.

Holtar, N. I., Nelson, M. J. and Togelius, J. (2013) "Audioverdrive: Exploring bidirectional communication between music and gameplay," in *Proceedings of the 2013 International Computer Music Conference*: 124–131.

Huiberts, S. and van Tol, R. (2008) "IEZA: A Framework For Game Audio," http://www.gamasutra.com/view/feature/131915/ieza_a_framework_for_game_audio.php . Accessed 3 October 2016.

Jørgensen, K. (2013) *Gameworld Interfaces*, Cambridge: MIT Press.

—— (2011) “Time for New Terminology? Diegetic and Nondiegetic Sounds in Computer Games Revisited,” in M. Grimshaw (ed.) *Game Sound Technology and Player Interaction. Concepts and Developments*. Hershey: Information Science Reference, pp. 78–97.

—— (2009) *A Comprehensive Study of Sound in Computer Games*. Lewiston: Edwin Mellen Press.

—— (2008) “Left in the Dark: Playing Computer Games with the Sound Turned Off,” in K. Collins (ed.) *From Pac-Man to Pop Music. Interactive Audio in Games and New Media*. Aldershot: Ashgate, pp.163–176.

—— (2007b) “On Transdiegetic Sounds in Computer Games,” in *Northern Lights: Digital Aesthetics and Communication* 5(1): 105–117.

—— (2007a) *“What are those grunts and growls over there?” Computer Game Audio and Player Action*. PhD dissertation. Copenhagen: University of Copenhagen.

Juul, J. (2005) *Half-Real. Videogames between Real Rules and Fictional Worlds*. Cambridge, Mass.: MIT Press.

Kassabian, A. (2001) *Hearing Film: Tracking Identifications in Contemporary Hollywood Film Music*. New York, London: Routledge.

Klevjer, R. (2007) *What is the Avatar? Fiction and Embodiment in Avatar-Based Singleplayer Computer Games*, PhD dissertation. Bergen: University of Bergen.

Marks, A. (2001): *The Complete Guide to Game Audio: For Composers, Musicians, Sound Designers, and Game Developers*. Focal Press.

Murphy, D. and Neff, F. (2011) “Spatial Sound for Computer Games and Virtual Reality,” in M. Grimshaw (ed.) *Game Sound Technology and Player Interaction. Concepts and Developments*. Hershey: Information Science Reference, pp. 287–312

Pidkameny, E, (2002) “Levels of Sound,” http://www.vgmusic.com/information/vgpaper2.html#intro. Accessed 15 May 2016.

Paul, L. J. (2008) “An Introduction to Granular Synthesis in Video Games,” in K. Collins (ed.) *From Pac-Man to Pop Music. Interactive Audio in Games and New Media*. Aldershot: Ashgate, pp. 134–149.

Ryan, M.-L. (2001) *Narrative as Virtual Reality: Immersion and Interactivity in Literature and Electronic Media*, Baltimore: Johns Hopkins University Press.

Sanger, G. (2003) The Fat Man on Game Audio: Tasty Morsels of Sonic Goodness.

Smith, J. (2009) “Bridging the Gap: Reconsidering the Border between Diegetic and Nondiegetic Music”, in *Music and the Moving Image* 2(1): 1–25.

Stockburger, A. (2003) “The Game Environment from an Auditive Perspetive,” *Proceedings of DiGRA: Level Up,* Utrecht, The Netherlands.

Stilwell, R. J. (2007) “The Fantastical Gap between Diegetic and Nondiegetic”, in D. Goldmark, L. Kramer and R. Leppert (eds.) *Beyond the Soundtrack: Representing Music in Cinema*. Berkeley: University of California Press, pp. 184–202.

Toprac, P. and Abdel-Megruid, A. (2010) “Causing Fear, Suspense, and Anxiety Using Sound Design in Computer Games”, in M. Grimshaw (ed.) *Game Sound Technology and Player Interaction. Concepts and Developments*. Hershey: Information Science Reference, pp. 176–191.

Walker, B.N. and Kramer, G. (2004) “Ecological Psychoacoustics and Auditory Displays: Hearing, Grouping, and Meaning Making,” in J.G. Neuhoff (ed.) *Ecological Psychoacoustics*. Amsterdam: Elsevier Academic Press.

Weske, J. (2000) “Digital Sound and Music in Computer Games”, *Neue Medien im Alltag*, TU Chemnitz, http://3daudio.info/gamesound/index.html. Accessed 3 October 2016.

Whalen, Z. (2004) “Play Along - An Approach to Videogame Music”, *Game Studies* 4, (1), http://www.gamestudies.org/0401/whalen/. Accessed 3 October 2016.

Winters, B. (2010) “The Non-Diegetic Fallacy: Film, Music, and Narrative Space”, *Music & Letter*s 91(2): 224–244.