4. Sound, Haptics, and Artistic Research

Approaches Beyond the Brinks of Game Space

Borderless Sound

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Abstract   For various technical and practical reasons, many games that are available on the PC platform allow the user to switch between different display modes. One of these is the windowed mode, where the visual side of gaming—in contrast to the constantly occurring spatial diffusion of sound—becomes an evidently framed experience through the sight of a screen within a screen. This particular situation calls to mind Michel Chion's theoretical musings on the spatial relations between image and sound in film, according to which sounds are of a more expansive nature than the moving image. In this article, I will pose the question whether the same can be said regarding audio-visual situations in video games. Keeping in mind that digital games are software and thus prone to all sorts of unintended relationships between image and sound, I will pay special attention to such faulty configurations. Rather than putting these in a negative light, however, I argue for a greater consideration of sound bugs in perceptual analyses of games.

Keywords   Audio-visuality, spatial relations, analysis, sound bugs

Introduction

Whenever a PC user starts up a modern video game and enters the graphics section in the settings menu, he or she is given the choice between three display modes, usually referred to as fullscreen, windowed, and windowed borderless mode. The particularity lies within the windowed mode in which it becomes apparent that the visual side of gaming is a rather framed experience when the player catches sight of a screen (marked by the window frame of the running application) *within* a screen (as indicated by the display bezels of the monitor, TV set, etc.). Even the other display modes merely create the illusion that one less instance of framing is involved as they make the bars around the windowed content indistinguishable from the remaining software application.

But why do I open a paper that bears the word "sound" in its title by referring to a purely visual and also quite boring technical process? After witnessing the maximisation and minimisation of game windows literally hundreds of times, at one point it occurred to me what Michel Chion had written about spatial relations between image and sound in the 'neighbouring' medium of film. Assuming that the following is of some significance also for video games, let me cite the relevant passage from Chion's formative book *Audio-vision: Sound on Screen*:

> If we can speak of an audiovisual scene, it is because the scenic space has boundaries, it is structured by the edges of the visual frame. Film sound is that which is contained or not contained *in an image*; there is no place of the sounds, no auditory scene already preexisting in the soundtrack […] (emphasis in the original, Chion 1994, 68).

Following this train of thought, it could be argued that unlike the visible content of a film, all its sonic occurrences are to a certain degree 'borderless' because they have to be projected—through loudspeakers—into a three-dimensional space instead of being projected onto a surface that happens to occupy only a small portion of said space. Nevertheless, it is this surface or, to be more precise, everything that is going on within the confines of the movie screen, which lets certain elements from the spatially diffused totality of film sound obtain their specific spatial identity. Again, in the words of Chion:

> What do sounds do when put together with a film image? They dispose themselves in relation to the frame and its content. Some are embraced as synchronous and onscreen, others wander at the surface and on the edges as offscreen. And still others position themselves clearly outside the diegesis, in an imaginary orchestra pit (nondiegetic music), or on a sort of balcony, the place of voiceovers. In short, we classify sounds in relation to what we see in the image, and this classification is constantly subject to revision, depending on changes in what we see (Chion 1994, 68).

So obviously we can make a fundamental distinction between sounds that become glued to characters, objects, and actions by virtue of exact audio-visual pairings during the editing of a film, and another class of sounds that have the potential to expand the cinematic space beyond the visible. Here we might think of sonic markers such as birdsong, the howling of wind, or the subtle background noise dubbed over certain locales, all of which help to define the spatial feel of a scene. And there are further sounds with no visible sources like disembodied voices or sudden impacts

outside the scenic space that may trigger an active auditory search for their cause on the part of the recipient. As is to be expected, the situation outlined turns out to be much more complex in practice, especially when the art of mixing comes into play. By carefully layering and processing the sonic materials, by exaggerating the properties of some and suppressing the characteristics of others, it is possible to constantly shift the borders of the perceived auditory space in relation to a film's visual content. Such manipulations of scale can in fact involve all types of sound, including those that have a clear analogy on-screen and would normally not stand out much. To illustrate this with an example, we can take a closer look at a chase sequence from *Blade Runner* (D: Ridley Scott, US/GB/HK 1982) that Chion only mentions in passing (cf. Chion 1994, 191). The scene begins with an extensive acoustic layout dominated by a large number of ambient sounds to represent the hustle and bustle of the surrounding city as protagonist Rick Deckard prepares to hunt down and eventually shoot the replicant Zhora Salome. In deliberate contrast to the rising tension of the ensuing manhunt, this vast backdrop of sound gradually makes room for a combination of gentle music and various emphasised sonic events. The externalised internal sound of heartbeat indicates the female character's battle with death, but at the same time it can be interpreted as the rhythmic foundation of the musical accompaniment. The gunshots as well as the shattering of glass are given their own space with the help of audio filtering and reverberation. This auditory impression is certainly reinforced by the concurrent use of slow-motion visuals.

Audio-Visual Spatiality in Video Games

Starting from the filmic situation just described, I would like to raise the question whether similar or maybe entirely different orchestrations of audio-visual spatiality can be found in a medium that depends completely on computerised processes for the construction of virtual worlds. While doing so, I have to be careful not to equate films and games unreservedly. After all, the concrete manifestation of a digital game breaks down into many personalised variants. Unlike watching a film whose images and sounds have been fixed along a clearly defined time axis, the audio-visual horizon of a video game usually results from the interaction between a given realm of possibilities and a series of decisions to be made individually. However, the very fact that digital games are software makes them susceptible to all sorts of unintended relationships between image and sound. So how does it affect the perception of a game's spatial boundaries when there is a mismatch between the said elements?

With these considerations in mind, I analysed several of my own gameplay videos that I recorded between December 2016 and November 2019.[1] Something that quickly emerged was that despite the dissimilarities between film production and video game development, and regardless of their media differences concerning audience agency, both film-like extensions and contractions of the perceived space can be observed in a game's interplay of image and sound. For instance, we find the heartbeat topos in *Blade Runner* and countless other films realised in a similar fashion during the opening level of *Destiny 2* (Bungie 2017). With the health bar almost drained, the player is forced to follow the game's decelerated pace after being severely wounded in combat. Since the richly orchestrated background music stopped shortly before, the remaining extremely low and regular bass thumps might be perceived as a kind of compositionally reduced funeral march. However, it is safe to assume that the almost infrasonic beats are primarily related to the physical condition of the avatar—an impression that is reinforced by the accompanying contractions of the image space, which seem to indicate the twitching of the heart muscle. The puzzle-platformer *Inside* (Playdead 2016) confronts us with a slightly different situation in which the nervous heartbeat of the avatar, who is a little boy lost in a strange and hostile world, transforms from a disproportionately loud internal sound into a musical part. From this moment on, one has to listen attentively and react in the course of a small rhythm game that also incorporates a sequence of footstep sounds into the musical fabric. Although the acoustic magnification of the heartbeat follows a predetermined cinematic pattern, the invitation to the player to manually connect with the sounds lies outside the possibilities of film.

One may also encounter configurations that can neither be clearly assigned to the world of film nor to the realm of games but rather adhere to the traditions of radiophonic art, in so far as time and space are almost exclusively evoked by sound. Such a thing occurs at the start of the Stone Age epic *Far Cry Primal* (Ubisoft Montreal 2016), which transports the player to the Mesolithic of Central Europe. The virtual journey through time begins acoustically. While the years tumble on the otherwise black screen, countless superimposed soundscapes present themselves to the ear. They consist of assembled language fragments from all around the world, sounding artefacts of human communication, transport and war, as well as scraps of music. The ringing of a cell phone gives way to a host of radio messages and Morse signals. Church bells calling for worship resound; after these, one hears ritualistic drums. The noises of a metro entering the station are followed by the puffing of a steam locomotive, the rattling of wooden carriages, and the clatter of hooves made by galloping horses. Machine gun salvos turn

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1   The situation of playing VR games with a head-mounted display is specifically not addressed in this article. It would be worth a separate investigation in the given context, seeing as how traditional notions of screening or rather of an enclosed visual space are beginning to crumble in view of full-circle projection.

into sword blows, which then morph into buzzing arrows and whistling slingshots. In a transition to the fourteenth century, a Gregorian chorale flashes up, replaced by the nasal tones of an ancient oboe, later by an archaic chant. All these tiny sound splinters indicate stages of civilization. The closer one gets to the target date, the more nebulous the acoustic events become. Undefinable swooshing noises and abstract bass eruptions gain the upper hand until the countdown effectively ends with a dull bang in the tenth millennium BCE. Interestingly enough, these last shadowy sounds, which stand for an unknown primeval auditory culture, are only filled with life in the course of the game as the successive growth of the Stone Age village, for which the player carries responsibility, is reflected in the increasing musical activity of its inhabitants.

On a much smaller scale than in the previous example, both the passing of time and the passage through space are sometimes made audible on loading screens, as is the case with the fast travel system in *Tom Clancy's The Division* (Massive Entertainment 2016). Although musical pieces and sound effects in such situations primarily serve to mask interruptions in the flow of the game (see also Summers 2016, 20), the developers here succeeded in transferring the game's winter landscape into travel noises to suggest a walk through snow-covered terrain surrounded by icy winds, even if the game is just on hold.

Traversing the Spaces (and Struggling with Time)

Up to this point, we have seen that creators of video games, very much like filmmakers, are well-versed in employing different combinations of visuals and sounds to make us forget that the internal spaces and places of a game are externally confined to a geometrical plane with some added electroacoustic transducers, be they loudspeakers or headphones. It is possible to tamper with the perceived proportions of the spaces on display through audio-visual trickery and in doing so, evoke a wide range of sensations between extreme trepidation and immense freedom, perhaps even undermine our spatial epistemology completely. The fact that we can navigate the represented worlds ourselves in games and that the pace as well as the extent of this movement can vary from moment to moment, may add a further level of meaning.[2]

What comes to mind immediately in this context is the standard gaming situation of racing against the clock. A simple means to musically reflect moments of growing threat and especially of playing under time pressure is to either up the musical tempo

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2   With regard to a staged expanse of open world games and their chronotope, i.e. the ideology between player-induced *free roaming* and the governed experience of quest lines induced by developers, see Bonner's chapter in this book.

or let the game engine cut to a second, more vividly composed piece. In *Far Cry 5* (Ubisoft Montreal, Toronto 2018), the sound designers went a different way by fabricating an extremely time-stretched version of The Platters' sentimental doo-wop song *Only You* (1955). Story-wise, the avatar, who was instilled with a hallucinogenic drug, is encapsulated in time. Accordingly, the player is doomed to repeat the level over and over again, until he or she has finally become skilled enough to gain access to the rest of the game. Thus, the dragged-out Platters piece perfectly captures both the narrative aspect and the player's temporary confinement.

In other cases, certain sonic assemblages serve to establish at least an aural connection to those areas in a game world that either cannot be accessed at all or cannot yet be entered. During the first chapter of *Uncharted: The Lost Legacy* (Naughty Dog 2017), players enter the rooftops of an unspecified Indian city in which a war is raging. Although parts of the city that are fiercely fought over remain inaccessible to the player, the camera work at this point invites one to pay attention to the distant events for a while. What attracts the most attention and expands the limits of the experienceable space noticeably are some faraway explosions, the wails of sirens and several other combat noises. At the same time, this accumulation of rather faint sounds marks the prelude to the deafening pursuit over the roofs that takes place shortly afterwards, in which the player-character Chloe Frazer is suddenly shot at from all sides.

A Tricky Comparison

As mentioned before, I am well aware of the problematic fact that at the heart of my observations on the audio-visuality of video games lies a book concerned with sound in cinema. A comparison of any kind between narrative films and digital games, however, will only be adequate if a game or at least parts of it present themselves in the spirit of film. And even then, such games can differ considerably from films in their acoustic internal structure. Listening closely to *Assassin's Creed Syndicate* (Ubisoft Quebec 2015), I noticed an exceptionally high level of detail in the sound design. Contrary to the cinematic practice of resorting to a few typified sounds for the characterisation of spaces and places (Chion 1994, 74–75), the acoustic environments in the game are extremely dense. In an attempt to authenticate Victorian London at the height of the Industrial Revolution, almost every passer-by, every carriage, every single horse hoof, indeed, all subjects and objects that can produce sound have been assigned distinct acoustic events. Depending on the locale, one will be confronted with situations in which, simultaneously, market criers advertise their goods, birds chirp their songs, a steam locomotive leaves the station, ship horns blare from the nearby River Thames, pedestrians have lively chats, horses gallop over the asphalt, and steam engines spring

to life. In the meantime, the player-character is involved in a conversation with the next quest giver. The relatively good audibility of such sound agglomerations is due to the fact that the intensities and locations of all audio assets are managed by the game engine in relation to the panning of the virtual camera and the position of the avatar (this may cause some problems in isolated cases, as I will explain later in the text with regard to *Red Dead Redemption 2*).

Furthermore, while calling movies and games in one breath we should bear in mind that the narrative-driven video game is not the rule. Round-based strategy titles or casual games like *Fated Kingdom* (GameLiberty 2019) and *The Elder Scrolls: Legends* (Dire Wolf Digital 2017) mark the continuation of board and card games by other means. If they nevertheless contain narrative set pieces, these are often conveyed in the style of comics instead of using virtual cinematography. Many video game classics, such as *Pong* (Atari 1972) and *Tetris* (Alexey Leonidovich Pajitnov 1984), manage without telling a story whatsoever. *Pokémon Go* (Niantic 2016) and similar titles use GPS to reproduce the model of a scavenger hunt, and the staging of today's sports simulations is based on the dramaturgy of live television broadcasts. Only traces of a cinematically informed practice can be discovered in the presentation of non-narrative games, particularly in the field of audio design. When, for example, a virtual card is played in the digital collectible card game *Hearthstone* (Blizzard Entertainment 2014), the character depicted on it makes itself loudly felt with a battle cry. At other times, an unseen audience bursts into cheers, thus pushing the boundaries of the visible game board.

The search for more recent theoretical frameworks emphasising the particularities of game audio in contrast to the sonic traditions that cinema brought forth inevitably leads to Kristine Jørgensen's insightful book chapter *Emphatic and Ecological Sounds in Gameworld Interfaces* as part of *The Routledge Companion to Screen Music and Sound* (2017). In pursuing the idea that game worlds should be seen as living ecosystems (Jørgensen 2017, 72, 75) where sounds, much like in the real world, indicate dynamic changes in the environment, Jørgensen puts forth a sonic interaction-communication model. In brief, she distinguishes between ecological sounds that players perceive as being more or less realistically "produced by a particular source inside the gameworld environment" (ibid., 79) and emphatic sounds. The latter has the main purpose to inform the player about issues related to gameplay mechanics, for example a shift in music that hints at the approach of enemies or various feedback signals when clicking through the inventory.[3] Jørgensen goes on to assess whether ecological as well

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3 An interesting hybrid of ecological and emphatic sounds can be found in *Ghost of Tsushima* (Sucker Punch Productions 2020). The open world game features some small animals, which are supposed to lead the player to specific points of interest. Since these critters are difficult to spot with the naked eye in the game's dense vegetation, hearing their distinctive calls almost automatically triggers a search reflex and eventually puts the player on the right path.

as emphatic sounds are "motivated by fictional or ludic coherence" (ibid.), whereby she aims to replace the common distinction between diegetic and nondiegetic events. Although her analytical categories are ideally suited to describing the functional aspects of individual sounds and how users might react to them, the sounds' material qualities remain largely ignored.

In a paper on the depiction of wilderness in video games, Marc Bonner quoted the art director Jan-Bart van Beek, saying: "Game worlds are always Disney-like versions of the real world. Everything is smaller. If a mountain is 3000 m high, we make it 300 m" (Bonner 2018, 17). And one would have to add that sound is often used to make things appear bigger again. The puppet-like dimensions of the characters in the *Dragon Age* series (BioWare 2009–2014) for example are hardly effective in giving the player a sense of power in combat. Instead, this is achieved by the eruptive, excessively loud nature of the sword blows and the acoustic swelling of the spells being cast, combined with the rumbling amplification of the lower frequency range. With the concrete sonority of the described elements, aesthetic categories come into play that exceed the purely functional facets of sound.

The Usefulness of Bugs

Since Jørgensen understands games primarily as living ecosystems, her theoretical framework is best suited for game worlds that actually simulate natural habitats and landscapes. Also, to conceive games as ecosystems carries with it the notion of an environment in which everything is always meaningfully related to each other. Therefore, it is not surprising that Jørgensen's functional model focuses on straightforward relationships between sounds, visuals and player actions. This actually leaves a lot of room for addressing all the ambiguities that result from the medium's charming susceptibility to error and imperfection. I would like to argue that bugs and glitches are an integral part of the gaming experience. We can observe this regularly on YouTube when content creators take great delight in compiling disruptions of game physics and geometry. For whatever reason, audio bugs are hardly a target here, even though they can be analytically quite relevant, as the shortcomings of media artefacts also allow drawing conclusions about their nature.[4]

Rather common are situations in which either faulty audio cues or inappropriate volumes undermine the originally intended perception of space. In *Far Cry New Dawn* (Ubisoft Montreal 2019), for instance, I was able to witness the inadvertent emergence

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4 A methodical problem with the analysis of bugs is that they cannot always be reproduced or only occur in a specific build of the game.

of a surreal space during the transition from an outside to an inside. This happened when I or my avatar, coming from outdoors, entered a collapsed highway tunnel in which there was a burnt-out bus. As soon as I walked through the bus wreck, a cheerful birdsong and the humming of insects replaced the tunnel's diffuse background noise. The soundscape in question, as if appearing in the interior of the bus in some magical way, was identical to the sounds of nature I had just heard in front of the tunnel entrance. Now, it unexpectedly repeated itself in an impossible space. A similarly confusing example can be found in *Shadow of the Tomb Raider* (Eidos Montreal 2018). Under certain circumstances, Lara Croft and one of her interlocutors are acoustically separated from each other, despite standing and talking in the same spot. This is most likely due to an incorrectly implemented reverb algorithm, as the acoustic properties of the cave where the conversation takes place affect only one of the two voices.

Another case in point which can be found online (Morgue & Mufasa 2018) demonstrates how sonic configurations that cannot be made sense of at all may interrupt the flow of a game. The disturbing element this time is an off-screen gunfight during a multiplayer session in *Fallout 76* (Bethesda Game Studios 2018) that should have been heard from afar. Instead, it strikes one of the players depicted in the online video with deafening intensity and leaves him disoriented. After finding out from his co-op partner that he is the only one capable of hearing the misleading noises, he spends the next few minutes searching the entire environment for the sound sources without ever finding them. Even if only the result of a technical malfunction, the inescapability of this acousmatic situation illustrates the potential of game sound to really become 'borderless' very well. This proves to be especially true when the player finally looks towards the sky and jokingly locates the origin of the noises there.

From obvious bugs, as they have just been described, we can distinguish audio-visual inconsistencies that are present in a game because certain features have not been implemented.[5] I will explain the difference by referring to two musical performances from *Horizon Zero Dawn* (Guerrilla Games 2017). The first one takes place in a tavern in Meridian where a house band provides musical entertainment for the guests.[6] At times, the execution can be plagued by an outright bug as the script telling the musicians to play their instruments is not carried out properly. Thus, the

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5   Or simply because certain audio cues are being interpreted with a time delay. In the prologue of *Star Wars Jedi: Fallen Order* (Respawn Entertainment 2019), the player-character has to fight his way through a moving freight train. As is to be expected, the train's driving noises change drastically as soon as it races through a tunnel. However, the acoustics of the open landscape are dragged into the tunnel for a short moment and it also takes a while for the tunnel acoustics to change back when the train exits. Since the process repeats itself many times, the insufficient simulation of the acoustic transitions is particularly striking.

6   For the role of taverns, marketplaces and squares in RPG games, see Bonello Rutter Giappone's and Vella's chapter in this book.

Fig. 1 Missing performance animations in *Horizon Zero Dawn*.

corresponding animations are nipped in the bud, although the music continues to play (» *Fig. 1*). In the same city, one may enter a church square where Carja Sun-Priests have gathered to recite a hymn. The vocal performance seems incomplete, however, as the priests vocalise with their mouths closed. Since it is highly unlikely that they are implanting their voices telepathically into the avatar Aloy's mind, and also because the scene always plays out exactly the same way, we can safely assume that it was simply not intended in the production process to bestow facial animations upon singing non-player characters.

Such examples are clear indicators of current limits to the creation of aesthetically convincing audio-visual correspondences in games. Sometimes it is simply the architecture of the developer tools that leads to irritating sensory impressions. While visiting the Saint Denis Vaudeville Theatre with avatar Arthur Morgan in *Red Dead Redemption 2* (Rockstar Studios 2018) to attend a performance of the can-can, I noticed a strange behaviour of the game engine trying to acoustically accommodate changing listening perspectives. When pushing the gamepad's thumbstick to the left or to the right, an audio filter was applied to the music, so that its high frequency components gradually disappeared with increasing camera movement, leaving a relatively dull sound. This kind of data mapping made me wonder whose point of audition the programmers intended to simulate. It could certainly not have been that of Morgan and his companion because both characters remained almost motionless in their seats, so why would the

acoustics around them change that drastically? And it was certainly not mine, since I was looking straight ahead at the screen. In fact, it was as if the invisible entity that we refer to as the virtual camera had my ears attached to it, but in a physically twisted way. First of all, the rotation of a real human body would never change the texture of the sounding music this much. And secondly, the changes only occurred when the camera rotated around the y-axis, seeing as the tilt of the artificial head had no effect on the frequency range whatsoever. From a technical point of view, here we are dealing with a global application of positional audio, which normally helps to differentiate between sonic events while steering the avatar but creates a somewhat impossible listening space in the given context.

This leads me back to the starting point of my investigation: If such significant discrepancies between the visible and the audible occur in the structure of a sound film, these are intentionally attempted rhetorical figures that have grown over many decades within an audio-visual language. Regardless of whether the sound sources used correspond to the sound events of the narrated world or whether what is heard merely pretends to be something it is not in reality, one will in principle be willing to accept the final sound shape of films as the result of calculated artistic decisions. Digital games, on the other hand, even though they largely share their playback conditions with those of filmic audio-visions, are temporally and spatially flexible forms that have to be ultimately realised as software.[7] As such, they run the risk of being perceived as imperfect or partly unfinished whenever the technical framework on which they are based begins to falter. Yet, the potential to toy with these imperfections may be one of the factors that make playing video games so appealing.

7   For a more complete discussion of this difference and its implications, see Erbe 2018.

Figure

Fig. 1: Screenshot by the author (Sony Interactive Entertainment 2017).

References

Ludography

Assassin's Creed Syndicate (Ubisoft Quebec, Ubisoft 2015).

Destiny 2 (Bungie, Activision 2017).

Dragon Age series (BioWare, Electronic Arts 2009–2014).

The Elder Scrolls: Legends (Dire Wolf Digital, Bethesda Softworks 2017).

Fallout 76 (Bethesda Game Studios, Bethesda Softworks 2018).

Far Cry 5 (Ubisoft Montreal, Toronto, Ubisoft 2018).

Far Cry New Dawn (Ubisoft Montreal, Ubisoft 2019).

Far Cry Primal (Ubisoft Montreal, Ubisoft 2016).

Fated Kingdom (GameLiberty, GameLiberty 2019).

Ghost of Tsushima (Sucker Punch Productions, Sony Interactive Entertainment 2020).

Hearthstone (Blizzard Entertainment, Blizzard Entertainment 2014).

Horizon Zero Dawn (Guerrilla Games, Sony Interactive Entertainment 2017).

Inside (Playdead, Playdead 2016).

Pokémon Go (Niantic, Niantic 2016).

Pong (Atari, Atari 1972).

Red Dead Redemption 2 (Rockstar Studios, Rockstar Games 2018).

Shadow of the Tomb Raider (Eidos Montreal, Square Enix 2018).

Star Wars Jedi: Fallen Order (Respawn Entertainment, Electronic Arts 2019).

Tetris (Alexey Leonidovich Pajitnov 1984).

Tom Clancy's The Division (Massive Entertainment, Ubisoft 2016).

Uncharted: The Lost Legacy (Naughty Dog, Sony Interactive Entertainment 2017).

Filmography

Blade Runner (D: Ridley Scott, US/GB/HK 1982).

Discography

The Platters. *Only You (And You Alone)*. Mercury Records, 1955.

Bibliography

Bonner, Marc. 2018. "Die gekerbte Wildnis: Inszenierungen vermeintlich unberührter Umwelt in digitalen Spielwelten." *Paidia: Zeitschrift für Computerspielforschung.* Published February 28. Accessed November 17, 2019. http://www.paidia.de/die-gekerbte-wildnis-inszenierungen-vermeintlich-unberuehrter-umwelt-in-digitalen-spielwelten/.

Chion, Michel. 1994. *Audio-vision: Sound on Screen*. Edited and translated by Claudia Gorbman. New York: Columbia University Press.

Erbe, Marcus. 2018. "Flüchtigkeit und Kontingenz: Die audiovisuelle Gestaltung digitaler Spiele in Relation zum Film." In *Filmmusik: Ein alternatives Kompendium*, edited by Frank Hentschel and Peter Moormann, 277–301. Wiesbaden: Springer VS.

Jørgensen, Kristine. 2017. "Emphatic and Ecological Sounds in Gameworld Interfaces." In *The Routledge Companion to Screen Music and Sound*, edited by Miguel Mera, Ronald Sadoff and Ben Winters, 72–84. London, New York: Routledge.

Morgue & Mufasa. 2018. "RIP Headphone Users FALLOUT 76 Sound Bug." YouTube video, 3:47. Posted November 4. Accessed November 17, 2019. https://www.youtube.com/watch?v=5g1eyXTYp1Q.

Summers, Tim. 2016. *Understanding Video Game Music*. Cambridge: Cambridge University Press.