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Beyond Sound

Inaugural professorial address of 30th October 2012, Aalborg University[1]

Introduction

When I began my research into computer game sound, that is, sound fx rather than the music or speech of computer games, 10 years ago, I was able to claim, three years later having submitted my PhD, that there had been only five articles published directly relating to game sound. While, in the intervening years between then and now, I have discovered a few other articles from that earlier period, I was quite correct in arguing in my thesis' very short literature review that there was a paucity of primary material to proceed from, particularly in the then newly developing area of Game Studies. I published my thesis in 2008; as far as I'm aware, it was the first academic book devoted solely to game sound beating by a matter of weeks the publication of my friend Karen Collin's efforts, albeit that hers was with a more reputable publisher. Since then, I have been sole author or co-author of over 20 game sound articles and book chapters and have edited a book on game sound in addition to many other writings in related areas such as virtuality or the Uncanny Valley.

I say all this not to boast but to point to the rapid increase in research and published output in the field. I am not alone in this endeavour and there are now numerous articles and book chapters on game sound published every year with several books on the subject available too. It is, for me, time to move on. While I will continue to maintain an interest in game sound, will continue to teach game sound, will continue to supervise PhD students in the area and will no doubt continue to publish in that field (I do still have a schedule of writing I have taken on), I wish to use this lecture to lay out a plan of study within a research domain that, until very recently, has been little more than a twinkle at the back of my mind's eye. Lest my new employers are starting to get worried at this point, let me assure them that this research is still, of course, to do with sound; my sorties into other areas notwithstanding, I believe there will continue to be innovative thinking and novel applications deriving from the

1 This text is presented as a record of my inaugural professorial address of 30th October 2012. The only edits are the removal of self-referential asides and light relief made during the address and the removal of references to the presentation of images and sounds. Additionally, I have added footnotes either as a response to questions or comments I received after the address or as a means to clarify or to expand upon some of the ideas presented.

study of our relationship to and use of sound and, besides, I have always thought of myself as a somewhat masochistic auralist in an overwhelmingly visual world.

My thinking about game sound is fundamental to the new focus I will be engaging in. I deliberately use the term 'focus' rather than 'direction'; it is not a complete break from my work of the last 10 years, merely a development building upon that foundation and that foundation has had implicit purpose underlying the explicit study of game sound. Accordingly, I will begin my address proper by providing a brief and limited overview of my and other's work in game sound as it informs my current thinking. I then suggest a future direction of game sound research, and its implications both for the experience of playing computer games and the wider context, before introducing my new focus.

The current state-of-the-art of game sound research

In 2003, I embarked upon a PhD in New Zealand that ended up with the title *The Acoustic Ecology of the First-Person Shooter*. The five articles I found in my PhD literature review were, among other things, proposals for categories of game sound usually for the purposes of analysis. This is a common enough approach to the study of a new subject. Compiling categories of things is a fundamental human method of organizing, if not understanding, the world. Some of these categories or taxonomies are based upon the work of film sound theorists such as Michel Chion and Rick Altman. Thus, terms such as acousmatic and visualized sound are used as well as diegetic and non-diegetic, and game music is usually treated differently to game soundfx. Further categories here include those based on the source object or cause of the sound such as character sounds and sounds from the game's environment.

The categories proposed by Friborg and Gärdenfors reference Pierre Schaeffer's and, later, Chion's uses of the terms causal listening, reduced listening and semantic listening to acknowledge the diverse ways that game players attend to sound. Röber and Masuch remind us that game music can have an emotional effect (although they do not suggest that game sound fx can have this effect too) and Stockburger further identifies the kinaesthetic qualities of game sound as a distinguishing feature to film sound; that is, unlike the film audience, players can react in the game in relation to heard sounds and thus have an effect on the direction and outcome of the game.

Although I was pursuing the idea of analyzing the sounds of the First-Person Shooter game as a soundscape according to the work of R. Murray Schafer and incorporating the role of the player in an acoustic ecology of the game, I must give credit to Breinbjerg for first proposing an ecological approach and naming a variety of sound spaces within the game. This was the approach that really interested me; placing the player at the centre of the game's sound world and its spaces and investigating what this meant in terms of perception and experience rather than deriving another set of categories to separate out sound sources in the game or simply further adapting film sound theory to games.

Lest I seem to be overly critical of the taxonomy method, I must guiltily hold up my hand and explain that my thesis too was full of new categories and, worse, replete with a host of neologisms. Many of these were developments of the term diegesis and so were concerned with the functions of sound within the exegesis of the game world. Developing this further, I also derived categories of game sound whose primary function I determined to concern space, location, time, period and relationships between players in multiplayer games as well as the cross-modality between image and sound.

Beyond these taxonomic endeavours, though, I was concerned with the player's participatory role in the construction of the game's soundscape -- various sounds are produced according to the player's actions -- and thus I formulated a framework of the Acoustic Ecology of the First Person Shooter with the player as contributing element of that ecology. Part of this framework derived from an investigation of the role of game sound in immersing the player in the game world. One understanding of immersion is that of the perception of being in one environment, in this case, that of the game world, to the exclusion of another, in this case the real world. The debate around immersion is rife with disagreement over terminology and usage and is further confused with concepts such as presence and flow, the former often being used interchangeably with immersion. For example, in English I can say that I am immersed in a book but is that the same form of immersion as claimed to be the case in the virtual world of the game? Conversely, if I can be dragged from a game by the scheduled necessity to teach a class of students, am I really immersed in the virtual world of the game or is perhaps virtuality simply part of reality?

Over and above these philosophical arguments, my interest was directed towards the ability of game sound to immerse the player in a field of sound and thus to aid in the immersion of the player in the game world itself. Game sound not only envelops the player and can stop other sounds from rudely intruding, especially if the player wears headphones, but, particularly in first-person perspective 3-dimensional games, it provides information about the game world beyond that which can be seen on the computer screen. This is as the situation is in reality with few exceptions. Contrast this to the visual aspect of the game: the graphics on the flat 2-dimensional screen must make use of artifice to mimic parallax and distance and the screen itself is but a small part of our field of view.

As previously mentioned, I have not been alone in building up what is now a substantial body of research on game sound. Among my fellow researchers are Kristine Jørgensen, who has expanded our thinking about the diegesis of game sound and game music, and Karen Collins, who among other things has worked in the area of generative music for games. Additionally, a large amount of work has been directed towards investigations of the psychological and physiological effects on the player of game sound and music. In a small-scale research project, conducted with colleagues at the Blekinge Institute of Technology in Sweden, I too have contributed to this body of knowledge with experiments using a range of psychophysiological methods as a means to investigate the player perception of immersion in the absence or presence

of game sound and game music. Game audio technology has likewise been developing apace and of interest here is the development of procedural audio techniques for game sound and game music. It allows us to design sound in real time according to the particular context of the game at that point in time rather than making exclusive use of pre-designed sound that rapidly becomes familiar.

The future direction of game sound research

Up until 2009, then, my work in game sound was focussed upon player perception of sound and increasingly focussed on the role of sound in enabling the perception of immersion in the game world. My movement towards the use of psychophysiological methods was directed towards this focus but I soon began to think about emotioneering and the uses of biofeedback. Emotioneering is the purposeful design of trajectories of emotion within the game using, in this case, the tools of sound processing and sound synthesis; the latter, using procedural audio techniques, can now be accomplished in real-time as gameplay progresses. Like literature, like music, and like films, computer games can engender a range of emotions in the player. As an example, horror-survival games borrow heavily from the genre of horror films not least in their use of sound and music. Sound in particular can be used for sheer sudden shock value, it can be used to build tension through forewarning and it can be used to unsettle the player through ambiguity, an ambiguity of location with respect to the player (who is typically being hunted and might prefer to know from which direction threatening sounds emanate) but also an ambiguity of sound source (is that the sound of a monster coming to eat me or is it the sound of someone wanting to be rescued?).

Accordingly, in collaboration with Tom Garner -- whom I must credit with doing most of the hard experimental work and thus allowing me the luxury of sitting back, assessing results, thinking and hopefully not taking too much credit -- I have asked the question: how do we go beyond simple analysis of the psychophysiology of the active game player to using those psychophysiological data within a biofeedback system to process and create game sounds in real-time in order to exert more fine-grained control over the emotions of the player. Put simply, in the context of a horror-survival game, can the game engine sense that the player is not frightened enough and thus be made to respond with ever more scary sounds? I sometimes think how fortunate it is, once we have finished scaring an experimental subject half to death, that we share premises with our Music Therapy colleagues.

I have little doubt that game design will progress in the direction of using psychophysiological data, biofeedback, to more closely integrate the player within the game world. This perhaps should be the real focus of the recently fashionable user-centred design movement, certainly as regards computer games; rather than asking the user to be a part of the prototype design process, the user's psychophysiology is utilized to design sound *in situ* and anew at each point in the game. And not just the sounds of the game; plot, non-player character responses, colour, lighting can all be manipu-

lated in this way. There are now available relatively cheap brain-computer interfaces (BCIs), measuring electroencephalography and, in some cases, electromyography, to be exploited for such purposes along with other biofeedback devices, such as those utilizing galvanic skin response or electrocardiography.

With these latter two methods, it is a relatively trivial matter to assess the player's level of excitement. What is more difficult to measure is the precise emotion a player is experiencing -- this is what the use of BCIs is intended to achieve -- but much work remains to be done on this and on defining which parameters of sound, and in which contexts, are best suited to engender fear let alone other emotions. Certainly, with the consumer devices we are testing, it is difficult to track emotion with a consistent degree of accuracy but early results, in this new field of emotioneering, while mixed, are promising. Coupled with the notion of user-centred design, biofeedback opens the door to increased personalization of game sound. A personal emotion profile might store, for example, records of the sound parameters in certain contexts that trigger required emotions or that keep the player at the required emotional pitch, whether that be increasing the fear factor or providing a much needed period of calm.

Although not of direct interest to me, other than in my new research focus, such an investigation of sound use and sound design in games has implications elsewhere. Clearly, any results or software systems that arise out of the study of game player psychophysiology have applications in other fields. Time precludes a listing of all but, if one can accurately and predictively track emotional responses to sound, then one can do the same for other modalities. This might be used, for example, in the use of colour, lighting and image for health and therapeutic purposes, not to mention the use of sound and music in this regard too. It might be used in conjunction with the artificial intelligence systems of computer-based relational agents and, as successful face-to-face communication is based in large part on perceived emotional empathy, it might go some way to mitigating the Uncanny Valley effect in the context of human-like robots and animated characters.

The new focus of my research

I now turn to my new focus in sound research. It will be an intensive study of the relationships between sound parameters and psychophysiology as a means to discovering fundamental meaning in sound. More specifically, and as a framework within which to conduct this research, what use can be made of any such relationships and the facilitation of creativity. As I have already stated, this is not a complete break with my past research in game sound; it is a development and a refocusing. If I and colleagues do discover anything, I have no doubt that it will be of use in the areas of emotioneering and personalization of game sound and so I hope to continue collaboration with current colleagues who will continue to work in that area in addition to pursuing new collaborations with researchers from other disciplines, many of whom I have met here.

With several definitions of what creativity is and how it arises, the most useful I find are those provided by Margaret Boden. A creative idea is an idea that not only has not occurred before but, under existing rules and structures, could not have occurred before. Contrast this to the merely novel idea: it might not have existed before but, under existing rules and structures, it could have. For example, the writing of a sentence or the composing of a sequence of notes are not necessarily creative expressions in themselves. As to how creativity arises, Boden suggests that this can happen through the exploration and transformation of constraining conceptual spaces, the aforementioned rules and structures underlying a domain of thinking. I am not one of those who think people can be taught to be creative -- and if we could do this, do we really wish to produce someone who is »conceited, cynical, disorderly, egotistical, hostile, outspoken, uninhibited, quarrelsome, aggressive, asocial, and, in the extreme, psychopathic« as Hans Eysenck describes the creative individual[2] -- but I am one of those who believes that it is possible to create an environment designed to enhance the potential for creative thinking to occur. Being a masochistic auralist in an overwhelmingly visual world, I believe such an environment can make use of sound to productive and creative effect.

For the past 10 years, alongside my research into game sound, I have been programming a Virtual Research Environment (VRE). Briefly, a VRE, particularly this one, stores bibliographic records and related data, allows a number of ways to organize, combine and retrieve those data and is accessed through a graphical web browser. I began this because I needed a way to organize the citations collected and ideas generated during my PhD as well as a way to rapidly collate and search through those data as I began to write my thesis. Being a poor student and with the impetuousness of relative youth, I also thought I could do better than the commercial products then available for bibliography maintenance. I continue to develop the VRE and it is in wide use around the world. I soon came to realize that, with its multi-user functionality and its discipline-agnostic structure, it was an ideal platform for exploring the facilitation of creative thought, where creativity is defined as earlier suggested, and for testing the use of sound for this purpose.

What's wrong with sticking to just image and text? you might be thinking. The more interesting question is perhaps: what benefits can sound bring to such a potentially creative space? Here is where I start to merge my thinking on the functionality and experience of sound (and game sound in particular) with thinking on the deployment of sound within a VRE. The key to the use of sound in such an environment is the exploration and transformation of conceptual space allied to user-centred design of meaningful sounds.

Firstly, the VRE is accessed through a personal computer. This immediately imposes a limit on the amount of useful data that can be visually and simultaneously displayed. One of the suggested reasons for Google having recently experienced a significant drop in profits is that fewer advertisements can be placed on a smartphone screen,

2 Hans J. Eysenck, "The Measurement of Creativity," in Dimensions of Creativity, ed. Margaret Boden, 233. Cambridge, Massachusetts: MIT Press, 1996.

a medium increasingly used to access the Internet and conduct web searches. Although I hesitate to suggest it as a potential solution to that problem, the use of sound to represent data opens another perceptual plane that can provide several other simultaneous streams of information in addition to those offered by image and text in a VRE.

Accessing the VRE through a computer requires that the user must focus the eyes upon, and move focus across, the screen; sound provides an alternative space that, used exclusively, allows the user to move beyond this sensory, and perhaps conceptual, restriction and, in providing a different or overlapping sensory and perceptual space in combination with that provided by sight, might be one key to exploring and transforming conceptual space. Our sense of hearing is also more sensitive to temporal change than our sense of sight; perhaps this can be used to advantage within a VRE that, in its amassing of data, grows and changes in many ways over time. On the other hand, having just distinguished between two senses, the consensus today is that we should no longer speak in terms of the four or five classical senses;[3] instead we should speak of the way our brain combines sensory information from various parts of the body into perceptual singularities. This suggests that research into the cross-modality of seeing and hearing in this context might be fruitful, particularly given the wealth of research on such cross-modality in other contexts, not least in computer games.

Sound in computer games, particularly in certain genres such as horror-survival games, can be ambiguous in terms of sound source. At the same time, sound, especially in a first-person perspective 3-dimensional game, provides a means to position the sound source within the game space. The player can use this sound to move through that game space to locate the source of the sound, a mode of listening that I have previously termed navigational listening. Humans tend towards wanting to find meaning in a sound. Thus, an innate curiosity will often propel us to discover the location and source of an unresolved sound as a first step towards that.

A VRE, such as the one I have created, is simply a container for data and does not care about what or how many fields of knowledge it is used for. Data are inherently useless; of more importance are how the data are accessed and combined and whether such modes of access prove to be of use for whatever purpose the access is initiated for. Access and combination implies selection and selection implies that some things are not selected and thus are not made available to the user for a number of reasons including restricted screen space. In this regard, certainly, it is useful to categorize data with terminology that may be drawn from a particular discipline's jargon and to use these as the access criteria. But while language *can* be ambiguous, the purpose of jargon is to disambiguate and to clarify meaning, even if only to those initiated in the mysteries of such jargon. Sometimes, I think, it might be useful to deliberately *ambiguate*, to be imprecise, as a way to explore and transform conceptual space. Rather than ask what is gained through precise categorization and the unambiguous, categorical use of jargon, I prefer to ask how much of worth is lost through this process of filtering out. Or, how can we get it right by getting it wrong?

3 Or more if we include newly announced senses such as the sense of 'smound'.

Here's an amusing but telling story. In the 1860s, Alexander Graham Bell read Hermann von Helmholtz's *Sensations of Tone* in the German original. However, his poor knowledge of the German language led him to mistakenly believe that von Helmholtz was claiming that vowel sounds could be transmitted electronically over wire whereas von Helmholtz had, in fact, explained that vowel sounds could be produced by sounding electro-magnetized tuning forks within acoustic resonators. This imprecision in translation and the resulting technological breakthrough as he attempted to recreate his mistaken understanding of von Helmholtz's work, led Bell to later state: »If I had been able to read German, I might never have begun my experiments in electricity [that led to the invention of the telephone].«[4,5]

The field of research I now wish to focus upon is one full of difficult questions. For example, what is the role of context on the perception of sound, of culture and individual experience; can one define and usefully use a metaphorical system of sound representing data and concepts with the same facility with which we use graphical symbols; and, conversely, can such a system be used alongside a more ambiguous sound system? Can listening to a set of data rather than viewing it really move us beyond analysis of that data set (as sonification of non-audio data has traditionally been used) to the exploration and transformation of conceptual space? Just how does one measure creativity?[6]

While the directional nature of sound in space should be useful in drawing a user's attention to something in the VRE, a deictic function, and might prove useful as a means to navigate the conceptual spaces of the VRE (think of the warmer/cooler children's exploration game), the ambiguity of sound in certain contexts might also provoke the curious to explore. And, while much has been written on music and emotion (the study of music is a more mature field after all), little investigation has been undertaken to understand sound and emotion or how we invest sounds (music and speech apart) with general or specific meaning. I have already mentioned some work in the field of computer games but there is also work, for instance, on the design and psychology of alarms, emotional responses to the sounds certain textiles make while being worn and the influence of different degrees of crunchiness of sound on the perception of the taste of potato crisps (yes, the crunchier they sound, the fresher and better they taste). Yet there is much, much more to be discovered.

4 Alexander Graham Bell quoted in John. M. Picker, Victorian Soundscapes, 100. New York: Oxford University Press, 2003.

5 The potential creative benefits of imprecision in language were demonstrated further and quite inadvertently during my address. I delivered the *Introduction* to the address in Danish, having started to learn the language eight months previously; those who have been in a similar position will understand the difficulties in pronunciation I experienced. Where I thought I was talking about *computer game sound* ('computerspillyd'), two members of the audience later asked me, jokingly I hope, why I had started talking about a *computer game shelter* or *hole* ('computerspilly'). Not all such misunderstandings prove creatively fruitful and, after turning the idea of computer game shelters 'round and 'round in my mind for a week, I had to admit that, though amusing, particularly in light of the circumstances, the idea was a creative dead end, leading to the conception of not a single metaphorical telephone.

6 There are a number of strategies presented by various contributors in Margaret Boden's anthology: Margaret Boden, *Dimensions of Creativity.* Cambridge, Massachusetts: MIT Press, 1996.

One intriguing theoretical field that might prove fruitful is that of sound symbolism or phonosemantics. This is a study of the meaning inherent in the (typically) initial consonantal phonemes of words. It is especially applicable to verbs and common nouns, those words concerned with actions and doing things or that have ambiguity of meaning. It shows that, certainly in English but possibly in other languages too, words having a common foundational sense tend to be grouped together under one initial phoneme to a greater extent than their grouping under another initial phoneme. Think now of 'kiki' and 'booba' and how typically almost all of us, regardless of culture or language, will associate the first term with the spiky, angular image and the second term with the blobby, round image.[7] Think also of our propensity to ascribe higher pitched sounds to smaller objects or rising frequency to increasing elevation.

I'm often called to task by some of my colleagues whenever I use the phrase *meaning in sound*, a phrase I have used liberally here. As if sound has an inherent meaning rather than a meaning we humans ascribe to it! And yet, from the above examples, there might well be something going on here. Yes, it might be the case, for example, that we associate high pitches with small things because small things tend to produce high pitches when they sound (think mouse compared to elephant or short piano string compared to long). But how does this explain the kiki/booba phenomenon and the phonosemantics of sound symbolism? Perhaps this has something to do with the shape our lips and mouths form as we speak the words. Perhaps it is the case that, as V.S. Ramachandran suggests, our brains are hard-wired with an abstract property, a metaphorical meaning or a general action gesture that can be commonly represented in both image and sound and that can be used to group objects together despite them ostensibly being sensed through individual sense modalities.[8]

In English, words associated with the general sense of bulging out tend to have an initial /b/ phoneme and are often associated with the letter 'l', for example: bag, bale, ball, balloon, barrel, belch, bell, belly, bilge, billow, bladder, blimp, blister, bloat, blob, blouse, blow, blubber, boil, boob, bosom, bubble, bulge, bum, bun/s, buoy, burl, burst, bust, bustle.[9] My hope is that this and other commonalities can be used to abstract metaphorical sound qualities that can then be used to access data in a VRE but with an ambiguity and imprecision that can be lacking in text (particularly well-edited text) and that this very ambiguity and imprecision can be used to explore and transform conceptual space.

My research question throughout will be: can sound play a role in forming an environment designed to enhance creative thinking? The answer to this might well be a

7 http://en.wikipedia.org/wiki/File:Booba-Kiki.svg

8 One of the claims of Embodied Cognition theory is: The environment is part of the cognitive system." (See Margaret Wilson, "Six Views of Embodied Cognition," *Psychonomic Bulletin & Review* 9/4 (2002): 625–636.) Although what is meant here is that the mind should not be the single domain of the study of cognition and that cognizer and situation/environment should be studied holistically, I prefer another reading as the basis for my speculative thinking: that meaning does not derive wholly from the mind of the cognizer and that, perhaps, base, fundamental meanings (for want of a better word – we are perpetually trapped in language) exist in the environment. It seems to me that, the more we study the natural world, the less tenable becomes our splendid, yet arrogant, isolationism, our human exceptionalism.

9 http://www.trismegistos.com/MagicalLetterPage/Dictionary.html#anchor717766

resounding 'no'. And yet, exploring this question is the pretext for an extended exploration of fundamental meaning in sound; the results obtained, while perhaps being of use to my research question, will have use in other applications and fields of study.

Discovering meaning in sound, ambiguous or not, provides, therefore, the basis, for this new research focus with the ultimate aim, for me, of designing a VRE that uses sound to facilitate creative thinking. In 2013, thanks to the generosity of the Obel Family Fund, Music Education within Aalborg University will take on several new PhD students and postdoctoral researchers who will be working in this same general field or in closely related areas. The next few years promise to be an interesting and exciting time indeed. And, who knows, you might just start to see an outpouring of wild, weird, wonderful, whacky and, yes, even creative ideas from myself and my colleagues.

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Abstracts

Min tiltrædelsesforelæsning tjente to formål. For det første gav den mig mulighed for at give et kort overblik over udviklingen af forskningen i computerspillyd inden for de sidste ti år, forskningens nuværende stade og overvejelser om den retning, den teknologiske udvikling af computerspillyd kan tage som følge af nyere forskning. Det andet formål var at markere et skift i min egen forskning og starten på et nyt forskningsfokus. Der er ikke tale om et fuldstændigt brud (jeg vil fortsat arbejde inden for computerspillyd-feltet), men snarere om en re-fokusering af min interesse for lyd i bredere forstand. Fokus vil her være på lydsemantik på et grundlæggende niveau (i modsætning til semantiske implikationer i musik og tale), og på hvordan eventuelle forskningsresultater kan anvendes til bredere lyddesign og interaktion.

This inaugural address served two purposes for me. Firstly, it provided the opportunity to present a brief overview of the development of academic research in computer game sound within the last ten years, the current state of the art, and speculation as to the direction the technological development of game sound might take as a result of recent research. The second purpose was to mark a personal shift in my research and the start of a new research focus. This is not a complete break (I will continue to work in the area of game sound) but, rather, a re-focusing of my wider concerns about sound. This will be a focus on the semantics of sound at a fundamental level (as opposed to the semantics of music and speech) and how any research findings might be applied to the wider field of sound design and interaction.