Sound Objects and Spatial Morphologies

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One of Pierre Schaeffer's achievements in his musical research was his proposal of the sound object as a basic unit of musical experience and his insistence on listening as a main focus of research. Out of this research grew a radical new music theory of sound-based composition. This article will draw on this extensive research to explore the spaces where this music is heard and present the claim that the space in which music is experienced is as much a part of the music as the timbral material itself. The key question here is the changes made to timbral material through acousmatic spatial listening and the subjective analysis affordance of the listeners' placement and perspective. These consequences are studied from a phenomenological and psychoacoustic perspective and it is suggested that Schaeffer's research on timbral and musical concepts can be extended to include spatial features.

1. INTRODUCTION

Listening usually takes place in a space and this space can have a large influence on how this listening is understood. This article poses a seemingly simple and basic question: how can we talk about the changes to listening imposed by spatial circumstances? How is the timbral content of composed material affected by these circumstances? The emphasis in this article is on an aesthetic and subjective analysis with reference to studies into spatial perception, spatial evaluation and spatial schemata. Specifically, the discussion will centre on the 'perceptual unknowns' which can follow from experiencing and performing electronic, electroacoustic or acousmatic music in different spaces. To discuss these spatial issues, the sound object is used as a basic perceptual unit. Pierre Schaeffer's proposal of the sound object as a mode of understanding sound as small perceptual blocks was a remarkable achievement, of which the effects are still being explored. The sound object is defined as a fragment of musical sound, suitable for study in itself. A sound object can encompass a range of significations and features, meaning that it can display many properties at the same time.

The practice of Schaeffer and his colleagues to analyse sound fragments arose from the repeated listening to locked groove phonograph discs (*sillion fermé*) where fragments could be listened to repeatedly. This attention and mode of analysis was later referred to as reduced listening (*écote réduite*). This shift in focus from the symbolic representation of music to the perceived material at hand sparked a new and extensive music theory of sound-based composition. Importantly, this theory was based on listening and not on visual input. When listening to music is diffused over loudspeakers, we are not privy to a visual experience which makes the perception of this music wholly centred on the ear. Yet, our spatial awareness is dependent on all our senses and it is the interplay between the senses which allows us to fully experience what we hear.

Music is not just an art of time but also of space, and music is never 'just' spatial but always spatio-temporal. The term *spatial audio*, popularly used to denote music which uses multichannel speaker technologies, could be said to be a pleonasm.[1] All music is inherently spatial, the experience of a violinist playing on a stage in a concert hall is as much a spatial experience as hearing a composition in a 50-channel speaker diffusion. Indeed, Blauert emphasises that 'space' should be understood 'as a set of points between which distances can be defined' (Blauert 1983: 4). And, in his book *Spatial Audio*, Rumsey points out that '[e]veryday life is full of three-dimensional sound experiences' (Rumsey 2001: 1).

As a term, *spatial audio* describes sets of tools and methods for how to represent and control sound material through a process of spatialisation but unfortunately the term is used both for multichannel arrays and for representations of soundfields over headphones, which renders it a rather vague term.

Rather than talking about spatial audio, what we should consider is that of *spatialisation*, which can be defined as an intentional placement of sounds in a given space through multichannel speaker arrays, a type of spatial sound design which seeks to convey information to its listeners through speaker technologies. As we talk about spatialisation, we need to be especially aware of the distinction Baalman (2010) makes between *techniques* and *technologies*. Specifically, that techniques are descriptive of the compositional process and how sounds could be choreographed in space, and technologies refer to

[1]In terms of the intentionality in hearing, Schaeffer (2017: 103) notes that *entendre* (to hear) has lost its meaning and that we must accept that different categories of ears, as musicians, linguists, acousticians etc., pose different objects of listening. Listening in spatial circumstances is no different.

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types of speaker arrays, encoding/decoding functions and panning methodology. This article is not a survey of spatialisation techniques or technologies but rather focuses on the consequences of the techniques and technologies of spatialisation.

Specifically, I will focus on the consequences of effects to listening in a sound spatialisation context. I will not attempt to 'categorise' spaces but rather will make the argument that the space the music is performed in is an integral part of the music itself and that space in itself should be viewed as a musical parameter. With this focus I will propose a theory of spatial analysis, which draws on Schaeffer's ideas on *reduced listening*, which will be introduced in section 2. This theory is further contextualised in section 3 with discussions focused on listening in the acousmatic situation.

Electroacoustic and acousmatic music are among the only musical forms in which spatial properties are a central exploration. The spatial arrangements in traditional stereo reproductions of rock, pop and similar genres does not have the same focus on spatial properties. In these genres the spatial experience has a limited relationship towards an actual physical space. The music is generally recorded in a studio one instrument at a time, with added panning and effects at the mixing stage, in order to construct an illusory space in which the song exists. Classical music recordings and related genres are dependent on the experience of a specific space and seek to reproduce an effect of the listener being present among the audience in a concert hall. Rather than focusing on a composer's working methods and the technical constructions of a work, we should consider its aesthetic, perceptual and spatial aspects.

2. PERCEIVING SPACE

In discussing installation art, Claire Bishop points out the subtle but important difference between the installation of art and installation art – when considering that 'a work of installation art, the space, and the ensemble of elements within it, are regarded in their entirety as a singular entity' (Bishop 2005: 6). Experiencing an installation immerses the spectators in the work and the work itself, the space and the spectators become part of the same perceptual unit.

With a fundamental focus on the technical and timbral properties of music, the spatial aspects can often be seen as an afterthought. Indeed, much of Schaeffer's *Traité* is on the treatment and classifications of sounds. Sound manipulation tools were the first frontier of this new music, from a long range of studios and research institutions around the world. Even now, which will be discussed in depth later, as tools for manipulating spatial trajectories and for composing with space have become more and versatile, many composers still work in the stereo format (Lyon 2014).

The history of electroacoustic music has produced many striking examples which highlights these experiences (for a good overview see Zvonar 2000). Early implementations of *trajectories sonores* were used by Schaeffer and Pierre Henry during the performance of their work *Symphonie pour un homme seul* (1949/50), where the work was spatialised over four speakers (Palombini 1993). Schaeffer and Henry used one elevated speaker which provides an indication that they did specifically consider the compositional value of elevated sound and possibly did understand that they could achieve a higher degree of listener envelopment this way. Likewise, *Gesang der Jünglinge* (1956) by Karlheinz Stockhausen used four channels surrounding the audience with a fifth channel overhead. We can view these performances as early experiments (Manning 1995) in using the room itself as an extension of the music. These pieces were performed in a traditional concert hall setting, with the audience seated and facing in one direction, making the sonic perspectives and the sonic projections much more predictable. Edgard Varèse's *Poème électronique* at the World's Fair in Brussels in 1958 used sound diffused over 400 loudspeakers accompanied by visual projections (Holmes 2008). Both *Poème électronique* and Iannis Xenakis's composition *Concrete PH* were written for performance in the pavilion, a space which would have a standing and moving audience that would make it near impossible to foresee the placements of all the audience members. The experience of these works was tied to this particular space and when hearing them in stereo format played back from a CD does not in any way capture the spatial relationships experienced when walking through the pavilion.

Interestingly, Pauline Oliveros set up a system consisting of various delay-lines accessible through various controllers (Oliveros 2003), where the manipulations of the delay lines could produce new acoustic spaces based on context and the ultimate morphological characteristics of the space of the performance. Trevor Wishart defines a 'sound landscape' to express the changes to the listening space by a composition and the subsequent 'new' space created (Wishart 1996). Stockhausen also stated that: 'New means change the method; new methods change the experience, and new experiences change man. Whenever we hear sounds we are changed: We are no longer the same after hearing certain sounds, and this is the more the case when we hear organised sounds, sounds organised by another human being: music' (Stockhausen 1971: 88).

Space is in some form always present (Ekeberg 2013) and the presentation of a work from the studio to the non-studio can in many regards make the transferral

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difficult for many composers. We experience spaces by listening not just by seeing, such as the way we can navigate in the dark. Blesser and Salter (2007: 127) argue that 'the principles of physical acoustics remain universal, their application to musical space is dictated by the values of the aural architects who are supposed to represent the composers, conductors and musicians, as well as the listeners in the audience'. Acoustic constraints, lack of technical skills and lack of experience can be difficult for many composers as the source material can end up sounding very different at the venue, which can introduce high levels of reflections and reverberation in comparison to the studio which is acoustically treated. In the studio we work in a controlled sphere, where changes to a parameter can easily be controlled but as we move into a different space, the more incontrollable morphological traits become prevalent and changes to a parameter can have unforeseen consequences.

2.1. Sound objects

Schaeffer commented that he and his colleagues practised phenomenology without realising it (Schaeffer 2017: 206) through the use of the phenomenological *epoché*. This practice of 'bracketing out' a sound, of removing information which is external to the object, enables a study of the object itself. Edmund Husserl recognised the epoché as necessary to gain an understanding of the everyday objects which surround us, 'this entire natural world therefore which is continually "there for us", "present to our hand", and will ever remain there' (Husserl 2012: 59). This 'natural attitude' is always present but in order to examine the world we need to suspend our understanding of it – we need to place the objects we wish to study in brackets, and Husserl substantiates this and says that 'The thesis is "put out of action", bracketed, it passes off into the modified status of "bracketed thesis", and the judgement *simpliciter* into "bracketed judgement"' (Husserl 2012: 58).

To arrive at the sound object, we must suspend our knowledge of the surrounding world in order to make subjective judgements about what we hear. The musical fragment is isolated from its cause and context. As such, the object is not an end in and of itself but is a method of analysis to draw out multiple features in an ontologically complex sound. The immanent objectivity in this listening is grounded on what Schaeffer refers to as targeting 'a particular object and the various modes through which I relate to this object: perception, memory, desire, imagination, and so forth. In what way is the object *immanent* in these? Because it constitutes an *intentional unit, involving acts of synthesis*' (Schaeffer 2017: 207, italics in original). Schaeffer's comment underlines that a sound object is a multidimensional unit.

Research on spatial perception and spatial hearing study how people understand what they hear in spatial contexts, in terms of perceptual cues in horizontal and elevated planes and how we locate sources. The spatial context and proposed theory of analysis this article deals with is not only considering concert halls, but any space which could be used as a performance space. As such, this article is not concerned specifically with reproduction methods or how to reproduce 'realistic' spatial reproductions. Spaces for the performance of electroacoustic music can vary greatly and can pose challenges to fixed media pieces and even so to live electronics.

A 'room', the space where music is performed, is a descriptor which does not necessarily convey to us any information about the inner workings of a space, apart from perhaps a statement on 'good' or 'bad' acoustics. To examine this descriptor, I will rely on the black box model as a method of analysis. The black box model is used to analyse the workings of a circuit, where the object of study is what changes can be recorded on the output based on what changes a system imparts on the input. The changes posed by a system is also the object of interpretation, specifically an interpretation which is reliant upon both the artist and the audience bringing knowledge and experience from everyday life (Ekeberg 2013) into the listening experience.

Acoustic instruments and models of analogue circuits can effectively be analysed for their salient properties using the black box model. Acoustic instruments have two main components: a sound source and one or more sound modifiers (Howard and Angus 2009). The inputs and outputs of the system can be simplified to be defined as that the output of the instrument is the input of the room. The morphological characteristics imposed on the instrument by the space is defined by Blesser and Salter as creating 'metainstruments' (Blesser and Salter 2007). The consequences of acousmatic listening are that the sources of sounds we are listening to are not visible, and are projected to us through loudspeakers (Godøy 2006). When faced with this listening situation, we experience sounds originating from a set of loudspeakers and our perception of these sounds is highly dependent on our placement in relation to the speakers, the radiation patterns of the speakers and the shape of the space. The spaces where the music is performed is integral to the music itself and as Worrall points out, the relationship between sound and space 'is not an abstract ideal' but rather that 'space is *in* the sound. The sound is *of* the space' (Worrall 1998: 97).

This is of course not to claim that this is a perception which is in any way unique to electroacoustic music. In traditional instrumental music we can, by vision, separate the direct instrumental sound and the influence of the room by both studying the gesture of the conductor, instrumentalist and by our previous knowledge of the music being performed. Griesinger (1997) believes that for room acoustics the aural impression is often dominated by the visual impression; Thompson, Graham and Russo (2005) find that the visual impact of popular music recordings enhances a sense of phrasing and anticipation of emotional changes in the perceivers. Later, Thomson, Russo and Quinto (2008) find that facial expressions in singers greatly influence the emotional interpretation of the music. By vision we can separate sources from the space and make judgements on the music, the acoustics and our perception of it. Indeed, in electroacoustic music we have visual contact with loudspeakers as an indication of the sound source, despite the 'actual' source being hidden.

3. MORPHOLOGICAL CONCEPTS

As mentioned earlier, sound objects are ontologically complex units and can contain multiple features and different guises which often cannot be easily distinguished. In defining perceptions of sound, Schaeffer structured four modes of listening to determine and to allow listeners to assess their mode of objective or subjective listening to the sound matter at hand. Rather than focusing on the derivation of a single feature, Schaeffer divides listening into four main categories, which are further divided into subcategories of subjective/objective and abstract/concrete with the aim of deriving understanding and knowledge about the sounds:

- *écouter* (to listen (objective/concrete))
- *ouïr* (to perceive aurally (subjective/concrete))
- *entendre* (to hear (subjective/abstract))
- *comprendre* (to understand (objective/abstract)) (Chion 2009; Schaeffer 2017).

Schaeffer's axis of the abstract and the concrete are contextualised through these modes of listening. These stems from Schaeffer's early experiments into what he named *musique concrète* (music made from concrete, real-world sounds – a term which was abandoned in 1958 in favor of *musique expérimentale)* and is further discussed as two 'isotopes of the real' (Schaeffer 2017: 8). The concept of the abstract and the concrete is divided as the concrete represents the how we hear a sound as it exists in the world and the abstract is what we hear after we have analysed and reduced the sound from its context to gain an understanding of the sound's salient properties. To be clear, the four modes of listening are not isolated modes of perception but rather are interdependent and interrelated (Kane 2014). The basis of Schaeffer's musical research is the listening experience and not any forms of symbolic representation, be they measurements or score notations (Godøy 2006).

Smalley (1997) added a *5ième écoute*, namely that of 'technological listening' or listening to technology. This occurs when a listener perceives or focuses on the technological processes behind the music rather than the music itself. As referred to earlier, a work's construction is what is often under scrutiny, which means that the *5ième écoute* is a frequently used listening method. When listening to music where the sources are hidden from view, then this could perhaps be a simpler mode of 'understanding' the music, yet it poses a problem because the technology is only a means to achieve a final goal, not a means in itself. The iterative process of repetition provided by the technology is a means to establishing the listening intention and 'it is through such swirling of intentions that links are established, information exchanged' (Schaeffer 2017: 272).[2]

Indeed, later theoreticians highlight some of the same relationships: Richard Rorty (1991) defines relationships in language as literal and metaphorical in terms of something familiar and unfamiliar. When new connections in languages are made, these connections pass over from the metaphorical to the literal. Also, in morphodynamic theory, this dual perception is divided into a control space and a morphology space (Godøy 1997, 2018). The control space represents any paradigms which can impose a change on a process and the morphological space is the perception of this change. This division between the abstract and the concrete also influences the separation of the symbol and the signal, it is the sound object itself we are studying not a sound which is reconstructed from a signal: 'the acoustician is concerned with two things: the sound object which he listens to, and the signal which he measures. From his erroneous viewpoint, all he has to do is first put down the physical signal, consider what he listens to be its result, and the sound object as a subjective manifestation' (Chion 2009: 16).

3.1. Symbol and signal

Musique concrète was theorised and practised as a mode of making music from real-world, concrete sounds. Through a process of reduction could we extract musical values and suitable materials for music composition from the materials of the real world. Schaeffer focused on the primacy of the ear (Landy 2007) and sought to create a mode of music making which transcended the abstract forms of musical notation which dominated classical music. Through the metaphor of the acousmatic curtain as a method of separation of sound and source, Schaeffer was very clear on what the sound object was not:

[2]In the original French, Schaeffer talked about a 'tourbillon d'intentions' – a maelstrom of intentions (Schaeffer 1966: 343).

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- The sound object is not the sound body.
- The sound object is not the physical signal.
- The sound object is not a recorded fragment.
- The sound object is not a notated symbol on a score.
- The sound object is not a state of mind. (Chion 2009: 32–3)

At the compositional stage sound objects are classified and described. Then by analysis of their musical structure, the composer can synthesise new sound objects (Landy 2007). Indeed, for many composers working with transformed sound material from many different sources 'it becomes difficult to remember from where the various sounds originated' (Wishart 1996: 67). It is when the sound object is contextualised in a performed, composed work that we can start to experience the perceptual effects of the performance space and this influences our understanding of the resulting auditory stream.

When moving the sounds from the studio into the performance space, the control over the non-anecdotal and reductive perception of the sound is gone. The sound world is thrown open and with that open to interpretation of the sources, origins, intended and unintended consequences of the sounds. Where Schaeffer insisted upon the perception of sounds as sounds and to disregard their causes, he tried to describe sonic material by placing it outside of history (Kane 2014) as an autonomous unit.

Schaeffer had introduced an idea on the motion of sound travelling between static loudspeakers – *trajectories sonores* (Harley 1998a) in his 1952 book *À la Recherche d'une Musique Concrète* (*The Search for Concrete Music*). Next to spatial trajectories, he wrote about static and kinematic relief, where static relief contrasts static and moving sound objects and kinematic relief denotes the movement of sound sources by gestures of the performer (Harley 1998b). The use of spatial projections and trajectories, along with the 'creation' of spaces, would suggest that Schaeffer considered space to be a musically important parameter in itself, yet he did not consider the potential consequences of the spatialisation as he did with the consequences of listening and analysing material in the studio.

The split between the auditory perception of source and the resulting processed sound will again be diffused when the reduced objects are presented as signals to be experienced during a performance. Dependent on the sounds, the listener can have very different experiences of the space portrayed in a composition. 'A sound mass, through density, texture and amplitude, can suggest a volume of space through implied spatial occupation' (Barrett 2002: 316). The space of a composition, the apparent source width the individual sound sources of a composition occupies can and will again be influenced by the performance space. Stating that 'the space of sounds – it is within that concept that the modality of acousmatic functions' (Bayle 2007: 242), François Bayle is directly concerned with how to occupy space in his compositions. Whereas many composers are tied to the loudspeakers as instruments, Bayle attempts to detach this notion and use 'the loudspeaker not as an instrument but as a projector of sonic images' (Desantos 1997: 14). Bayle has been more interested in exploiting the loudspeakers to create ambiguous spaces to 'create sounds emerging in irregular motion from ambiguous locations' (Desantos 1997: 13–14). These types of spatial design are interesting because they can combine musical elements which would be perceived artistically weak had they not had this distribution.

3.2. Ontological differentiations

We have seen so far that the features of sound objects become available to us through a listening intention, reduced listening, which allows us to examine and analyse salient properties of a musical fragment. Then, it is important to establish and discuss the correlations between the information related to room acoustics and to the musical, sonic information to examine the variations in sensorial value and to examine the structural relationships between the various objects and their spatial correlate.

The black box model allows for an extension to reduced listening analysis of the subjective spatial perception of our listening experience. We experience music in a space (enclosed or open) and this has a considerable bearing on the perceived experience, often the morphological characteristics of a space can complement a performance of electroacoustic music. For Schaeffer, the phenomenological reduction was intrinsic in his formulation of the acousmatic situation, and this reduction seeks to 'create an investigation containing its own immanent logic, structure and objectivity' (Kane 2014: 34) in order for the composer to experience and sense the sound object.

For this purpose, the black box is an addition to the phenomenological reduction which Schaeffer based his listening theories on – a reduction which allows us to make subjective judgements, based on listening, to the actual effects of a room on a sound. In the *Traité*, Schaeffer refers to the relationships between the physicist's signal analysis and the studies of the experimental musician as that of *anamorphoses*, or warping, which is derived from a visual phenomenon where a distorted image appears normal when viewed from a specific angle. The acoustician would seek to explain the black box of the individual (Chion 2009: 16) but the musical experimenter should study the sound world for itself. Observing a sound object is only possible by listening to it again (Chion 2016) and by each subsequent listening we understand more of the sound's properties.

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The physical signal is in itself not a sound object and the non-linear relationships between the subjective and acoustic features of a sound are briefly noted by Chion as the acoustician's 'erroneous viewpoint'. This failing of the acoustician to see the true relationship between the physical signal and the perceived sound is grounded upon the separation of the signal of the measurement as an objective description of the perceived sound, and as the acoustician is concerned with the signal which is measured, 'he forgets that it is the sound object itself, which is given in the process of perception, that determines the signal to be studied' (Chion 2009: 16). This perspective reminds us that the black box model treats the room as an 'unknown' and it is through listening to the resulting sound that we can establish the changes imparted to a sound by the space we are listening in.

Music perceived in a spatial setting like a concert hall can be described by the two terms 'spatial impression' and 'spaciousness'. Spatial impression is a term used to describe whether a room is perceived to be large or small, and spaciousness describes how enveloping a space is perceived to be (Blauert 1983; Griesinger 1997, 1999). Derived from work on concert hall acoustics, this psychoacoustic research can offer us valuable insights into evaluations of electroacoustic music through the perception of qualities in reproduced instrumental music. Despite existing standards, spaciousness, spatial impression and envelopment are interpreted variably in the literature and as multidimensional features they can be difficult to pin down. The term 'spatial impression' has generally been used as a 'cover all' term (Rumsey 2002), where envelopment is defined as a listener being surrounded by sound and engulfment is considered a unique 3D audio attribute, which rather than being surrounded by sounds, produces a sense 'of being covered over' (Sazdov, Paine and Stevens 2007: 4).

Unfortunately, according to Griesinger (1997), several researchers equate 'spaciousness' with apparent source width (ASW) and he goes on to highlight that 'a concert hall can be spacious, the reverberation of an oboe can be spacious, but the sonic image of an oboe cannot be spacious' (Griesinger 1997: 721). Thus, the term 'spaciousness' is used to describe the degree to which we perceive a room to be enveloping but this has no bearing on the perception of the source. In smaller rooms ASW has little relevance as it is difficult to distinguish if the sound image is wide or just diffuse (Griesinger 1999).

It is important to emphasise that these attributes are multidimensional and must be studied in their interaction, as we must with complex sonic material. For electroacoustic music, these attributes can be more unclear and can pose problems by attempting to separate the perceived acousmatic source from the spaces in which it is performed. The 'Locations of sounds (both moving and static) can help with the stream segregation of sounds; that is, it is possible to distinguish different sonic streams from each other, because the sounds will be coming from a different position' (Baalman 2010: 210).

Albert Bregman's theory on Auditory Scene Analysis (1990) describes a process by which a listener can separate multiple sounds within an audio scene into discrete auditory streams. Stream segregation can help us in determining the spatial trajectories of the sounds and their localisation but determining where the sound ends and the space begins is a more complex endeavour. Earlier studies have shown that if listeners are unfamiliar with the sources and the space, localisation can be difficult but the auditory system is able to quickly become familiar with both the sound sources and the room conditions (Plenge 1974). Indeed, when listening to multiple sound sources coming from one loudspeaker we would have a problem separating the sources but this changes as the number of loudspeakers increase. Here we can 'tune in' to one or the other, dependent on the one we wish to follow (Pierce 1999). This is also referred to as 'the cocktail party effect', which is described as our ability to follow what one person is saying in a room full of chatter from other people (Bregman 1994: 529; Pierce 1999: 90).

4. SEPARATION OF SPACE AND SIGNAL

The sound object and the study of sound fragments enables a certain level of resolution to be part of our focus (Godøy 2006), which offers a different focus than the study of large-scale forms. This mode of analysis at the compositional stage allows us to examine, classify and quantify the sounds we are dealing with.

When listening to music in a concert setting, we perceive the direct sound, emitted from the source, and the indirect sound, where the sound has been reflected off one or more surfaces. Concert halls, venues, galleries, bars and all places which can be used for the performance of music sound different. The space the music is performed in becomes an integral part of the music itself and the morphological changes to the music creates a contextual relationship which can be accessed through reduction.

Griesinger (1997) has found that the sonic background of a performance space can have unique timbral and spatial properties and the sonic background can impose very distinct morphological characteristics on the sound which is projected through the space. These changes imposed by the space are also described as timbral coloration of the sound. Smalley uses the term 'spatiomorphology' to highlight space as an experience in itself and specifically when hearing a space through spectromorphology (Smalley 1997). The perception of spatiomorphology is tied up to timbral

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composition and is firmly grounded in the perception of space *in* the composition, rather than examining the spatial concerns in the performance of the music. Smalley's timbral classifications are important in analysing timbral composition but do little in terms of analysing spatial concerns. Building on these spectromorphological categories, Smalley later (2007) theorises spatial concerns in acousmatic music and through rigorous classification and analysis of the different types of spatial groupings offers composers modes of integration in different approaches to acousmatic music, specifically so that 'we can use spatial concepts to investigate soundscapes, source-bonded approaches, and more "abstract" or "abstracted approaches" to celebrating the unique richness of the only aesthetic medium that can truly explore sonic space' (Smalley 2007: 55).

We can, through our experiences and conditioning, recognise and understand a musical phrase performed on an acoustic instrument. From this knowledge and experience we can separate the source from the perceived influence from the room. Electroacoustic music does not follow the same timbral recognisability and the host of different effect and processing techniques available through technology can provide a range of expressibility which is not available to other music. In these situations, separating the resulting sound from the space could be next to impossible.

For example, during a concert you could experience certain modulations of the sound material which perhaps did not sound intended based on the preceding material. And as a sound is faded down, it turns out that the composition had masked background sounds such as a ventilation system and the effects experienced as part of the work were in fact external to the work. This would profoundly change your experience of the work given that the timbral and spatial qualities of the work fuse with the sounds of the room.

Music posits an ontological problem, in its nature as an intangible and temporal existence (apart from the score or the recording), yet something which often is referred to as a powerful physical being (Cox 2017). Being in a listening situation we are not just faced with a sound and our only experience is of this *one* sound, but rather we perceive an apparent source, this source's relation to the listener through the analogue-to-digital converters, cables, speakers, walls, floors, ceiling and other listeners. To gain an understanding of this spatio-temporal experience and to attempt to access and analyse these sounds, we can look to this proposed theory of separating the space from the signal.

Through reduction, we seek to discard all information which is not available to us through an immediate perception of the phenomena which appear to us present in consciousness. Our conscious awareness makes up only a small part of our perception of the world, where objects retreat to some hidden realm which supports our perceptions but seldom make themselves visible (Harman 2011b). Our intentional focus is on an object before us in perception and 'all perception, judgement, love, hate is perception, judgement, love, hate of *some object*' (Harman 2011a: 173). At any time, we only come in contact with very few features of the objects we encounter and when we love or hate some object, we love or hate some features of that object.

4.1. Spatial morphologies

If we focus intently on our perception, when we are faced with a circle or dome of speakers, the room (walls, floor, ceiling, drapes, windows), the audience, the chairs and our own listening perspective becomes our point of focus. Just as isolating a single sound object in the studio, in the concert hall we are in a spatial setting confronted by a type of *macro-object* where we are faced with the total sound of the work and the space fused together.

A move from one space to another can, and probably will, prompt the use of EQing and filtering to compensate for the altered perception of the work in the new space. This can be a difficult position for many composers, where the desire most likely will be to communicate the exact sounds which were produced in the studio, without the morphological changes imparted by the space. The perception of spatialised music usually happens in specific acoustic environments, 'and the choice of these conditions may be part of a composition' (Trochimczyk 2001: 40). Not only the choice of venue and space but also all the changes imparted by the space becomes a part of the composition. The spaces are as integral to the work as the work itself.

Despite multichannel diffusion being an integral part of the development of early electroacoustic music (Holmes 2008; Manning 1995), a survey conducted among 52 composers find that both technological constrains and problematic spaces contribute to the lack of use of multichannel composition (Peters, Marentakis and McAdams 2011). Among the issues recognised by composers is that many venues make equidistant loudspeaker setups difficult (as many rendering algorithms require carefully installed and calibrated speakers) and also that ideal placements of speakers would not be possible due to constraints with stage or lighting design (Peters et al. 2011: 16). Some of these problems, next to the fact that many composers only have access to stereo setups in their studios and do not have ready access to multichannel facilities could be among the issues which is 'holding spatial music back' (Lyon 2014: 851).

RT60 (reverberation time) is a measure of how long it takes for the sound pressure level (SPL) to drop by 60dB (Howard and Angus 2009: 301). This is an easily understood parameter but it says nothing about the amount of reflections, arrival times of these or their

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strength, which cause rooms with the same RT60 to sound very different (Halmrast 2015). We experience the room effect as the direct sound, followed a series of early reflections and (late) reverberation. If a reflection arrives later than 30 ms after the direct sound it is perceived as a distinct echo. According to Rumsey (2001), early reflections 50–80 ms after the direct sound can have a broadening of the spatial effect of the sources. The early reflections can cause interference effects in the direct sound, particularly from comb filtering (Halmrast 2011) and all interferences from the surrounding space introduce coloration in the sound, which is experienced as changes in timbre (Halmrast 2000). These changes in timbre influence the way in which we perceive the sounds which arrive at our ears and the grouping of these sounds into a coherent whole. This coherent whole is our understanding, perception and analysis of a composed work.

Despite the potentially distorting effects of reverberation, a recent study which samples 271 spaces from daily life, not just concert halls, has found that human listeners are able to distinguish both source and environment from an incoming sound (Traer and McDermott 2016). These findings indicate that humans rely on the acoustic effects of the environments which they encounter to correctly interpret sound and partially separate reverberant sound from a sound source, indicating it as a cocktail party problem 'rather than simply a source of distortion or noise' (Traer and McDermott 2016: E7863). This study finds that listeners can distinguish the environment in which a sound exists effectively. However, when viewed in the context of electroacoustic music, this study has significant shortfalls as it rests on the use of impulses, short speech samples and modulated noise rather than the timbral and textured complexity frequently encountered in electroacoustic music.

5. EMBODIED OBJECTS AND SPACES

The sound object was defined as originating externally but existing in the listener's consciousness based on a listener's specific perspective and listening situation. When listening to music we extract information from a continuous sensory stream, which indicates that there is an ongoing mental simulation where we process sensory information as a re-enactment of what we perceive (Godøy 2006; Wilson and Knoblich 2005). The sound object is the 'sound itself, considered as sound, and not the material object' (Schaeffer 2017: 8) and likewise, it is not 'the psychology of the auditor that matters, it is the particular spot where the latter is positioned that does' (Chion 2016: 172). It is our particular spatial position when listening to music which matters in both our understanding and our analysis of what we hear. Our unfamiliarity with the sounds and with the spatial conditions can quickly change, given listening intention. We try to understand our context dependent on the perspective from which we experience our situation by attempting to recognise patterns and make connections between what we hear (Kendall 2010). Faced with the acousmatic listening experience, listening is our primary mode of analysis and the breakdown of the incoming auditory stream is 'a multimodal, embodied experience of objects and actions' (Kendall 2010: 68). This theory of spatial reductive listening embodies a subjective mode of analysis to access these experiences from our particular position.

The control of relative amplitudes of distributed audio material to a set of loudspeakers generally does not address issues of precedence (Kendall and Ardila 2008); if the signals played back over the speakers are different, they will be perceived as different sources comings from different spatial locations and our spatial segregation will work more clearly. Indeed, Halmrast has pointed out that 'the average person perhaps does not notice such coloration of the sound because often there are several surfaces at different distances that more or less randomise the comb filters, or perhaps the person has not experienced the original/direct sound by itself, unmodified by the reflection' (Halmrast 2015: 257).

The salient properties of a sound which is examined and studied in the studio can quickly be changed when the sound is perceived in a different space. Then we experience that 'no sound event, musical or otherwise, can be isolated from the spatial and temporal conditions of its physical signal propagation' (Augoyard and Torgue 2014: 4). The act of reduction on a sound leaves us with the sound itself but when we perform the same reduction in a space other than the studio, we are not just left with the space itself, but the inevitable interplay between the sound, the space and the listeners – and the experience of the sound being *of* the space.

6. CONCLUSION

The relationship between the heard sound and the 'room' has been the contextual focus in this article, as something else than a measured objective signal. The room is an object which the listener forms in his or her conscious mind while listening to music and this emerges in response to an auditory experience. The conception of the room forms through a reduction of information to access the direct salient features of the listening experience. By an intentional focus in our listening we draw out important features about what we hear in the interplay between the space and the sound. A large part of programme notes and CD liner notes which follow many electroacoustic works can be very vague in terms of musical meaning and have a strong weight on a work's structure, construction and approaches to timbral manipulation. And in the cases of multichannel presentations of works, the compositional reflections on a work's spatial aspects are more or less gone, apart from maybe specifying which order of ambisonics the work is made in.

Pierre Schaeffer theorised the sound object as an intentional unit in musical research as a means of analysing sounds for their salient properties. His use of the phenomenological epoché of 'bracketing out' a sound to examine its salient qualities has in this article been proposed expanded to include spatial features. Through this article I have attempted to discuss the issue of how spatial circumstances pose changes to our listening by focusing on the listening experience and the uncontrollable acoustical circumstances surrounding it.

The main elements of the discussion are based around the timbral changes to sounds made by reflections and randomisation of filters, the perspective of a listener dependent on his/her placement in a room surrounded by speakers and the repeated focus on the need to listen to the resulting sound in the space where the source and the space fused to a single entity. Much of the acoustic literature is concerned with concert halls and it is argued that regardless of space of performance, the morphologies imposed by the space to the source as apprehended by the listeners should be considered as part of the music. This article has proposed a mode of analysis of the subsequently received auditory stream grounded in Schaeffer's 'reduction to the object' to expand the 'new' experience of the music and the distribution of sound objects in the space. Specifically, this enables a subjective analysis based on the listeners' placement and perspective, rather than a measurement and analysis made from an idealised centre. This reduction treats the room as a black box of perceptual unknowns and if we are to free ourselves from symbolic representations of measurements to make judgements about the space, we need to suspend everything but our listening to be able to make artistic and aesthetic judgements about the space and the music. Listening was at the heart of Schaeffer's musical research practice and it should be so for us.

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