Quantum Echoes:

Spatial Sound Practice & Embodiment through Sonic Immersion

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Abstract

Spatial sound practice has been establishing itself in American and European art and music culture since the mid-20th century and is now just becoming self-aware. Finally being incorporated into formal institutional and educational settings, there is interest brewing in its development, but questions surrounding its relevance. Coming out of both theory and practice-based inquiry, sound practitioners, theorists, and composers spanning a wide range of disciplines are looking at sound from a variety of perspectives including but not limited to technology, acoustics, experimental composition, perception, therapy, meditation and relational aesthetics. There is a sense of accountability for individuals to acquire broadened knowledge bases, for example, producers engaging with the psychology of music or artists understanding the physics of sound. The infrastructure for this kind of work is complex, as it is ephemeral, time-based, and uses technological structures that art galleries and institutions are just starting to understand and implement. Creating an awareness of sound art, design, and composition methods that actively utilize a spatial practice will open the doors to widened options for this practice to be integrated to the daily public sphere, for experiential art research to be embraced, and for a wider range of sonic work to be created.

This thesis looks at sonic phenomena through combined theory and practice, a set of research interests that come to life from an immersive, multichannel soundscape installation called *Quantum Echoes*. I look at how sound brings light and life to various concepts: time, space, hearing, acoustics, consciousness, embodiment, listening, amongst others. I explore sound as a catalyst, a mode of transport, a non-material, non-object, a vessel into expansive thought and embodied experience. I argue that immersive sound is a relational "non-medium" that affects us directly, viscerally, emotionally, and spiritually in a way that is not governed by the visual. As much as sound is something we hear, it is something that we feel. I investigate how immersion and embodied listening can induce felt, holistic, self-conscious awareness that we can apply to daily life, and how sound specifically can be a tool for attuning ourselves to our perception and our environments.

Introduction

My interest in sound has come from an ever-evolving interest in and strong sensitivity to sensory phenomena: how light projects through window glass and warms us, the reflections and shadows of water and trees, the crunch of boots in snow on a winter street. Through keen attentiveness to these sensory phenomena, where otherwise disconnected, I have been able gain a sense of connection to my surroundings and to the greater whole of things. I have found a sense of the sublime, even the spiritual, in realizing through phenomenological experience that I am connected to things beyond myself. This intuitive discovery results both from a sense of personal and social dislocation in my upbringing and from a sense of distrust in the ways in which modern society compartmentalize daily experience. In America's late capitalist society, we have prioritized consumption over creation. We have become obsessed with the gleaming surfaces of commercial products, exploiting people for profit. We live in a world deeply saturated with media, a loud and flashy world of industry that degrades our hearing every time we listen. In fact, we've forgotten how to listen, how to sit with merely the thoughts in our heads, and take charge of our perception. Spatial sound practice has given me the space and the time to combat this, to become more in tune with my senses, to simply "be" in real space and real time, to sit with myself and my environment on a number levels. I've been able to shift my focus from looking or the object of our looking, to a more integrated, embodied sense of "being" in the world every day.

The trajectory towards this sense of "being" started from a young age through the act of making, first building things on my own in my basement, then becoming a

saxophonist, then a multi-media artist and sculptor. I moved from creating large-scale sculptural installations to exploring projection, light, and shadow in space. I became interested in phenomenological experience. Then I re-discovered sound. I began viewing sound not in musical terms, but as a sculptural phenomenon shaped by Newtonian physics and imagined through visual language. I made recordings and installed them in spaces, all creating some sense of the unexpected, uncanny, or otherworldly amidst the every day. As I've progressed in my arts practice, I've felt a responsibility to learn the science of sound and through this, have come to realize how integrated space and sound actually are. As a result, sound has taken a more relational position in my mind and its object-hood has de-materialized. I've realized that if this kind of sound is governed by physics, it is not the Newtonian kind, governed by predictable laws, but in fact, the "quantum" kind, where time expands and disappears, opening up my mind to infinite possibilities.

As sound reflects off spaces and bodies, we can gain more information about the world and ourselves in conjunction, a more complex, multi-dimensional state of experience. Sound can make us aware of our spectrum of perception, blur our notions of reality, therefore propelling the realization that we have the ability to create it and change it. As we create an awareness of sound, we create more of an awareness of ourselves individually and culturally. As sound artist Bill Fontana said (1996), "My work exists one foot in and out of contemporary music, one foot in and out of contemporary art, on the edge of some science, on the edge of philosophy. Sound enters so many different worlds." (Licht, p. 274) Perhaps because Sound Art has been lingering in this in between space for so long, is why he found sound to be a lost medium, even back in the 1970s. (Licht, 2007) My hope is to bring more

physicality and awareness to it through this paper and the soundscape installation, *Quantum Echoes*, first through broader conceptual interests, followed by a reflection on the work.

Background Essay

I. Timing

"Whenever we judge anything to exist in time, we are in error. And whenever we perceive anything to exist in time--which is the only way in which we ever do perceive things--we are perceiving it more or less as it really is not." -J. McTaggert

"The very experience of time has become a paradox. We have access to sounds of the past, but all of them seem to be part of the present in some great collage of juxtapositions. And yet, we are emotionally succeptible to the bringing back to life of a sound that has long been silenced. Bringing back all the feelings associated with the original sound. Sound recording is a powerful link to the past." -Traux

Like experimental music pioneer, John Cage once said in regards to music composition, "Synchronicity argues that there are, in effect, two ways of looking at time. One sees time as being marked by a series of events, which happen one after another. The other is a more typical of the grand philosophies of Taoism or Buddhism in which equal attention is paid to what is happening in the same moment, what is synchronized." (Richards, 1996) In Western culture, time circulates around tasks, around linear events that have a beginning and ending. The idea of progress, or moving from one point to another bleeds into our daily lives. In a sense, composers are philosophers of time. When one is creating sound or music, one is in effect creating or removing a sense of time. Iannis Xenakis spoke of the idea of "temporal differentiation," that in producing modes of sonic-spatial experience that transcend Euclidean space, where a listener can perceive

differently according to their own location, time is no longer absolute and they can open their mind to diversity and simultaneity. (Born, 2013)

Likewise, Karlheinz Stockhausen's compositional tools involved a process he called "moment forming" and the idea of synchronous time. A bit like the effect of listening to white noise, moment formed music presents the idea that all sound is happening at all times. What this states is that sound has the ability to reveal alternative views on time, in my view, time's omnipresent nature. (Samuel, 1996) In revealing this omnipresence, one can say that time does not exist, or that sound dismantles notions of linear time.

We resonate with sounds of the past. We can experience the present yet physically "be" elsewhere through it. Sound triggers a distinct sense of the past, especially because the memory and emotion centers of our brains are linked. When we hear a sound, we are not just hearing a sound from the past, but that sound initiates full-body memory and emotions associated with that moment into the present moment. (Samuel, 1996) A psycho-acoustic effect called anamnesis merges sound, perception, and memory, through the triggering of past mental images into the present state. (Augoyard & Torgue, 2006) We can compensate for the losses of hearing impairment by melding perceptual inputs. By integrating the physicality of sound; through the subwoofer, we can gather memories and images of sound as related to space. (Saks, 2007) By hearing a past sound in the present, it in a sense becomes part of the present.

Sound is a force that brings light to a perspective on time that is about our perceptive engagement. In the field of phenomenological psychology, Gerald Edelman (2012) talks about "the remembered present," that every act of perception is to some degree an act of creation. (Edelman, Fekete & Zach, 2012) In his view, there are three facets

of consciousness: the sensory facet or the "primal impression," the impressions and sensations existing in the here and now, the "primary memory" or "retention": the awareness of recent history, and "protention": my anticipation of the future of a thing or event. In opposition to this multi-faceted view, cognitive neuroscience presents the view that our responses to the world are "stationary". (Edelman, Fekete & Zach, 2012) This stems from Husserl's phenomenology and view that time is the infrastructure of reality.[1]

These two conceptions look at time as a "feature" of conscious experience, claiming that we must somehow 'embody' temporality. (Edelman, Fekete & Zach, 2012) Another conception is that of the "dynamical systems perspective" which is more about describing something through a lens rather than trying to claim that it objectively exists as an entity. (Edelmen, Fekete, Zach) So if we are to fuse the dynamical systems perspective with the idea that on some level we can have an awareness of primary memory, protention, and retention simultaneously, we could say that temporality gives us the space to reconfigure self-awareness and reflect, an awareness of trajectory over time. (Edelman, Fekete & Zach, 2012) Jorge Luis Borges (1968) wrote in "The New Refutation of Time," "Time is the substance of which I am made. Time is a river that sweeps me along, but I am the river; it is a tiger that mangles me, but I am the tiger; it is a fire that consumes me, but I am the fire." (Borges)

What better way to 'embody time' than through sound. When we embody time through sound, we are first able to perceive timelessness because time is not external to us. There is a balance between our inner clock and outer actions. If we think about our time not

[1] Husserl presented the view that we "constitute" objects within our perception. They are not something merely external to us, nor defined by our relation to "objective" reality, telling us about the world outside of us. The object is a result of group of perceptual functions, and perception is a component of reality. It points to the perceiver as being an agent in how they experience reality, shifting from a positivist orientation of science during his time.

as dictated by our routines, it is actually something we can shape. Secondly, listening to sound allows consciousness to take place continuously, creating a sense of the eternal within a limited environment. (Edelman, Fekete, Zach, 2012) This "eternal" notion has often been associated with quantum physics, where music is "a multi-dimensional, unfolding process and a relationship between an individual or group of individual and sound vibrations" (Juett, 2010), resulting in what Oliveros calls a "quantum listening" experience. (Juett, 2010) She says this is the "edge" or the border where compositional possibilities emerge. (Juett, 2010) Sound waves literally can go on forever if there is nothing to attenuate them. This can even be thought of as resilience, survival, or the resistance to time._Spatial sound practice maximizes embodied experience expanding our time sense into the perceptual infinite.

II. Spacing

"Always what was important to me was the notion of being immersed in enveloping space, and the sensation that you're fully enveloped,... it's not about interactivity but the fact that you are spatially encompassed and spatially surrounded---it's all around---and that's what sound is."
-Dyson

"When space is understood not in abstract or absolute terms, but as socially and politically constituted, a spatial sound practice can emerge not only as a poetics, but as a politics, not only as an aesthetics, but as an ethics. such a critical spatial sonic practice does not merely 'happen in space, but is poised radically to transform the very terms of its constitution."
-Born

Space can be looked at as a reflecting container of sound. Depending on the type of space and the positioning of our bodies, we will experience sound differently. We can look at sound as being imprinted with spatial information from its source onward. Acoustically, sense of spatiality is created through the size and type of space, how much waves are free

to travel and how much they reflect off of matter. Augoyard and Torgue state an extremely important point in *Sonic Experience*, that sound cannot merely be described in terms of signals. In a psychoacoustic sense, perception of sound is integrally linked to both environment and conditions of hearing and listening. (Augoyard & Torgue, 2006) I'm looking at a combined theory of acoustics where I believe the energy transfer model is very real, but then acknowledge the listener's positioning in space through Traux's communicational approach. [2] (Traux, 2009) Since sound is invisible, it is hard to describe, and we begin to think of it as a "thing" separate from space rather than a "spatial phenomenon." I want to add another idea that sounds are signals or waves, flowing through space. I want to look at sound as encoded waves or energy that also embody a context, that do not actually become audible until they vibrate, resonate, and reflect off of something in space such as air particles or the walls of a room, and it then becomes subjective depending on how it is perceived by the brain. I want to know sound for its powerful invisibility and presence, not locked within the confines of Newtonian physics, through the confines of our visual perception, or through the way we choose to name it. "Sound is intrinsically relational, and at the core of sound art is an activation of the existing relation between sound and space." (Born, 2013, p. 17)

Figure 1

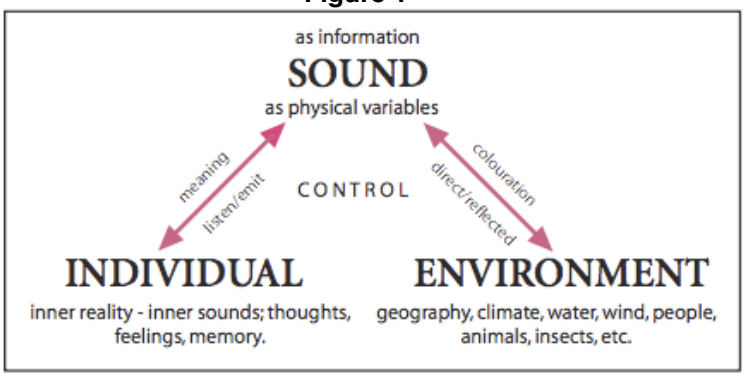

Figure 2: The mediating relationship of an individual to the environment through sound (modified from Truax 1984, 11).

[2] In ecological acoustics, one looks at how sounds relate to one another and to their environment.

In the early 1940s, with the rise of musique concrète began the notion of a spatial sound practice and an investigation into sonic perception. Pierre Schaeffer's "objets sonores" or sound objects were not material as dictated by the external world, the visual, or even subjective experience, but occurring as perceptual spatial events. The process of reduced listening he used is comparable to Husserl's (1901) philosophical views that "in that by shifting attention away from the physical object that causes my auditory perception, back towards the content of this perception, the goal is to become aware of precisely what it is in my perception." (Kane, p. 206–8). His concept of "acousmatics" was about hearing sounds simply for their concrete reality, with no relation to its source or any visual marker of where they are coming from. (Iges, 2000) Later on, Merleau-Ponty revised Husserl's concepts of phenomenology to say that the body is deeply engrained in our perception, and as our experience of the senses is always happening through our perceptive body, they cannot be disentangled. (Merleau-Ponty, 1945)

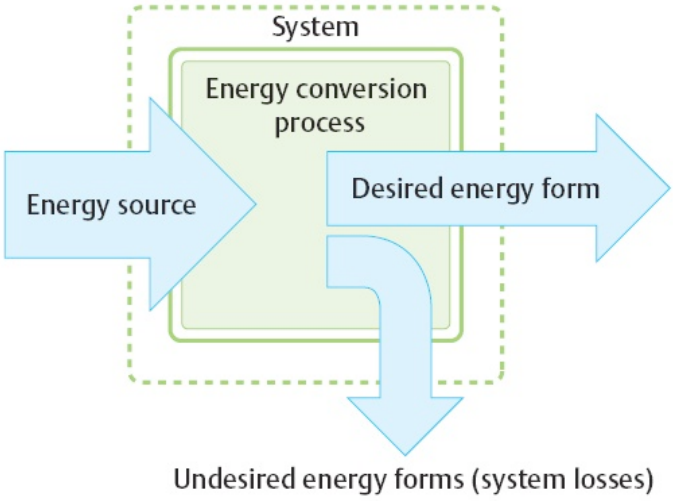

Figure 2

During the early musique concrète performances, Schaeffer used the idea of spatial diffusion or movement of sound along sonic trajectories, with static and dynamic sources of sound controlled by a performer. Pierre Henry diffused magnetic tape stereo recordings to multiple loudspeakers. These sorts of compositions focused on temporal, spectral and spatial development of sounds, not always taking into account relations between them.

Multichannel setups were embraced by composers like Stockhausen. (Bates, 2009) Composers such as Boulez and Brant also used space as a compositional parameter of sound since the mid-20th century. (Bates, 2009) Various spatialization techniques have been adopted into musical composition, including multichannel techniques like stereophony[3] or ambisonics[4] and wave field synthesis[5]. Speaker layout plays a large role in sense of space, and these effects can also be recreated on headphones, through convolution with HRTFs and various types of signal processing.

In the late 1960s, R. Murray Schafer coined the term "schizophonia" as to describe our disconnect from the source of sounds. He believed that all sounds and music are part of one ecology, or that all sounds should be treated equally. (Traux, 2000) He thought that industrialization has forced us into separating the natural from the man-made, lo-fi from high-fi, or schizophonic, the split between an original sound and its electroacoustic transmission or reproduction. (Traux, 2000) Jonathan Sterne finds this idea of sonic essentialism to be counter-productive, as thinking about a source point for sound in contrast to what it has become through technology assumes that the process in which it evolves through is somehow separate or devolving in nature. (Traux, 2000) He thinks by speaking this way about a loss of sound from its origin is only a further way of separating it from its cultural position.

What I am talking about here is what current sound artists speak of as a "spatial sound practice", and in doing so, I am taking all of the above into consideration in my own

[3] sound reproduction system that creates a sense of three-dimensional sound through two channels

[4] a spherical surround sound technique that uses not only the horizontal plane, but height channels to create a more realistic sense of a space

[5] a technique that produces artificial wave fronts from a series of speakers in a way in which localization perception does not change when the listener's position changes

practice. I relate to Schaffaer's focus on getting at the reality of what a sound is, void of all mental constructions and external associations. Simultaneously, I do find this to be a bit too reductivist, and grab hold to the ideas of sound ecology, perception as related to the body, and subjective, psychological experience of sound. I am looking at sound events not as just happening in space, but being a reflector of space and all of the acoustical elements of space and them being fully integrated into composition. I am also looking at the listener's mind as affected by the sound. In effect, we are no longer talking about Euclidian space, possibly space-time, but most probably, as Michel Serres puts it, "spacing and timing" or "relation propositions."

III. Hearing

"Hearing is a way of touching at a distance." -Dyson

"We are immersed in vibrations whether we perceive them or not" -Nancy

Sound is all around us all the time, and we hear it because the hairs in our cochlea vibrate at certain frequencies and the nerves in our body and brains receive electrical impulses. We are affected physically.

> Although sounds and even more general noise emissions are not visible and not tangible, they are nevertheless physical realities inasmuch as they exist as pressure differences in the air, mechanical vibrations in the middle ear, liquid vibrations in the inner ear and finally as electrical impulses in the nerves leading to the brain. Just as radio waves, light waves and the electrons circling the atomic nucleus are

> characterized by time and space dimensions, so it is also with sound and other noise emission in all forms. (Winckel, 1967, p. 4-5)

Sound is not just something we hear, it is something we sense. In sound, things like contour, tonality, and interval sizes are not as diverse or distinct. Many sounds don't really have a discernible pitch, we just hear them as generally high or low, based on their frequency, which is still a bit subjective. (Huron, 1996) Highly unrelated frequencies and inharmonic components would be what we consider "noise." (Orbach, 1999) I would concur that this "tonal ambiguity" might be a reason we don't pay as much attention to the sounds around us as we do to music. It is certainly not common that we find ourselves humming the sound of cars going by. Times when non-musical sounds tend to really alarm us is when they are loud (outside the range of the human voice): intense, very low, very high or severely isolated. We may be alarmed by a siren or a birdcall, but these are very tonal examples of sounds, and they are usually louder that the natural listening range of a human is. We can easily categorize what sounds are because there are really only a handful that we need to be aware of for survival, and we hear them all the time whether we are conscious of them or not.

Acoustic events yield sound waves that flow in all directions reflecting or diffracting off of objects and the listener at different times. Both direct sound and indirect sound affect the listener's perception of the sound source. High frequencies tend to reflect away while lows wrap around the body of the listener. (Kendall, 1995) Localization of sound is based upon what is called the duplex theory. It states that there are two primary cues we use in localizing a sound. One is the inter-aural level difference (ILD). If a sound is louder at one ear over the other we infer that source is in the direction of the ear where it is louder or the

ipsilateral (closest) ear. This is due to the head shadow affect where the actual mass and shape of the head blocks sound from reaching the contralateral (furthest) ear. The other primary cue is the inter-aural time difference (ITD) and takes into account the difference in time it takes a waveform to propagate from the ipsilateral ear to the contralateral one. Which cue is used is frequency dependent with ILDs working in the range above approximately 1500 Hz and ITDs below approximately 1500 Hz. (Kendall) This 1500 Hz threshold is due to the length of the audio waveform. Below 1500 Hz the waveforms begin to wrap around the listener's head and the mass of the head is no longer effective at attenuation. Localization of sound sources is typically denoted in spherical coordinates. These coordinates are in angles of azimuth and elevation.

When a sound is transmitted between two or more loudspeakers that are located within relative proximity of each other a phantom image (or location) of the sound source is created that appears to be between the actual speaker locations depending the amplitude at each speaker. When these sounds reach each ear a single auditory object is perceived with a directional location. This is known as summing localization and how the location of the phantom image is perceived. (Pulkki) If a listener's head faced forward is located along the median plane between two loudspeakers there is little head shadow effect and difference in amplitudes from each speaker can create virtual ITD differences down to about 400 Hz.

Zahorik talks about perceived distance in that azimuth and elevation of a sound source are only part of the story, that there is an unaccounted for dimensionality to the source, or a width. Along with distance perception, spatial precept cues are also

multidimensional. Also, environmental context plays a large role in distance perception, primarily things like reverberation caused by room reflections.

> Like a light source on a painting, the sound reflections from the surfaces of an enclosure or in the outdoor environment can potentially cause a significant effect on how a sound source is perceived. (Zahorik, 2002)

Primary and secondary localized sound sources perceived cause an effect on the virtual sound source's location and the formation of a sound source image made by the listener. (Zahorik, 2002) Zahorik mentions that in room environments, intensity and direct-to-reverberant energy ratio are the primary cues to distance, therefore in auditory displays such as a multi-channel sound system, it is important to present consistent changes as to these cues to create a semi-realistic image. Of course things like type of source signal, direction, and distance play into this as well. Familiarity of sounds also plays a huge role in distance perception. So can spectral content relative to a receiver's position (Begault, 2000) Non-acoustical factors, like vision, affect sonic perception. When we look at sound as object, we are framing it within the confines of our visual perception. It is stated by neurobiologists like Seth Horowitz that our visual system is much more convoluted and much less direct to the brain than our auditory system. (Horowitz, 2013) Since we refer to things "as fast as the speed of light", even if not explicitly stated, in western culture, sight is understood to be the fastest sense. Having visible targets entices us to associate a sound with a source image. Even seeing a speaker or a person makes us perceive that any sound will come from that visible source. For both directional localization and distance localization, this phenomenon is known as the ventriloquism effect. (Zahorik, 2002)

IV. Perceiving

"Every sensory interaction relates back to us not the object/phenomenon perceived, but that object/ phenomenon filtered, shaped and produced by the sense employed in its perception." -Born

"The thing can never be separated from someone who perceives it; nor can it ever actually be in itself because its articulations are the very ones of our existence, and because it is posited at the end of a gaze or at the conclusion of a sensory exploration that invests it with humanity." -Merleau-Ponty

Psychoacoustic experience[6] has more to do with our expectations than we realize, but psychophysics tells us that without the spatialization of sound and its context in a room literally causes us to lose the sense of its emotional and perceptual dimension. Our perception, on a base level is already limited. We schematize the world in order to make sense of it. This human tendency to compartmentalize experience can be heightened and expanded through sound. As is clear from the "Timing" section, sound's time-based nature allows us to acquire an evolving conception of its nature. As Edelman and Fekete illustrate, perception is also a shifting phenomenon. So, sound's multidimensional nature highlights a way in which to look at perception also as multidimensional.

A good way to study the multidimensional perceptual effects of sound is to look by looking at individuals' experiences in its complete absence. Oliver Sacks, in his book *Musicophilia* describes the different (but strangely overlapping) experiences of those with hearing loss. Some noticeable effects include interestingly enough that perception of timbre, pitch, tempo---the qualities of music and sound do not change, but that the dimensions of the music do change. (Sacks, 2007) Patients have described that the space

[6] By psychoacoustic experience, I am referring to the internal psychological interpretation of sound, whereas psychophysics refers to room acoustics and our bodily, physiological experience of sound.

plays a key role in the emotional experience of it; reverberation of the room, spaciousness contributes to the emotional effect, otherwise it is perceived as flat and lifeless.

In an experiment where the listeners listened to music with an earplug in one ear, the experience was described as "causing not only a problem in judging depth and distance, but unexpectedly far reaching, causing not only a flattening of the whole visual world, but a flattening that is both perceptual and emotional." (Sacks, 2007) The listeners also spoke of feeling disconnected, having difficulty in relating spatially and emotionally to what they were seeing. One patient who suffered from a brain aneurism with severe bleeding in his frontal lobes, experienced a general loss of emotion and expression, but singing was able to bring that sensation back in him. "It was as if music, its intentionality and feeling, could 'unlock' him or serve as a sort of substitute or prosthesis for his frontal lobes and provide him the emotional mechanisms he seemingly lacked." (Sacks, 2007) The transformation was not only felt by him but was neurologically observable.

This is only the beginning of an exploration into the assertion that our perception can literally be expanded through sound. According to music psychologist Jeanne Bamberger, hearing sound is a process of instant perceptual problem solving, and hearing in new ways is learning to enrich one's own understanding of music, to perceive in new ways. (Bamberger, Jean, 1978-86) I think this can also be applied to hearing any sound. To expand perception means to expand mental restrictions or conventions; freedom of creativity, freedom from expectation. Between the spatial and temporal delay of a sound wave's cycle, there lies a moment where we are actually able to become aware of our perception, in turn giving us the time to perceive. Psychoacoustically, the word "stereo" infers a spatio-temporal disparity (which can be applied to hearing or vision). We use these differences to create a

larger perceptual landscape and to formulate impressions or opinions about what is heard/ seen. (Sacks, 2007) The inner ear acts like "a prism for sound", separating it into its pure frequency components, and is reflected on the basilar membrane. (Sacks, 2007) Other psycho-acoustical phenomena such as delocalization and desynchronization can distort our perception of reality. It is possible to engage in sonic illusions while still knowing that they are not realistically happening in time and space. This phenomenon occurs when the listener recognizes that the sound is out of place while being conscious that it is an illusion.

Embedded in the very nature of sound is the concept of awareness creation, starting from a very practical sort of awareness to a more creative awareness. From all perspectives: biology, physiology, etc., sound's initial apparent purpose in our lives was to keep us more attuned to our environment. As Seth Horowitz says in his book, "The Universal Sense: How Hearing Shapes the Mind," we are always hearing when we can't see. (Horowitz, 2013) Even back while our convoluted visual system is working hard to give us a clear picture of reality, our auditory system is converting auditory information from waves to mechanical energy into an electrical signal that travels to our brain much faster. Sound can provide us the "what is" quite clearly in multiple dimensions over time, while sight can give us a somewhat artificial representation or flattened version of "what is" by piecing together the moment. [7] We may be able to see the image but there is nothing as direct as the heard.

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[7] The dictionary definition of the term "sound" lists a variety of meanings: As a noun, it describes sound as particular auditory impression, the sensation perceived by the sense of hearing, mechanical radiant energy that is transmitted by longitudinal pressure waves in a material medium (as air) and is the objective cause of hearing recorded auditory material, meaningless noise. As a verb, sound means to make known, to measure the depth of, to look into or investigate the possibility. As an adjective, *of sleep*. deeply and completely. to the full extent; thoroughly. free from error, fallacy, or misapprehension, deep and undisturbed, showing good judgment or sense. From meaningless noise to hidden energy to a radiant alarm, the term innately holds a multi-layered meaning.

V. Embodying

"Listening as an activity, an interactivity, that produces and invents and demands of the listener a complicity and commitment that rethinks existing philosophies of perception." -Juett

When we experience sound, our bodies act as both a mobile "architecture" and a "sensor" of an environment. By architecture I do not mean a static, enclosed entity, but a soluble container. We absorb what is around us, while also being containers of our own internal sounds, our own individual experiences. As I will explain in a later section, listening is not limited to the ears. What "embodied" art does for the viewer is to replaced a dualistic "mind/body" with an integrative notion of "mindbody", to create a "body conscious" experience. We are a series of evolving relations rather than static entities. (Dyson, 2009) By displacing sound from its original context, sound art (in this case, spatial sound) can activate the senses, putting us more or less in touch with our environment creating new perceptual possibilities. We might experience a space in one way with its natural sound, but once that sound is magnified or dislocated, it brings new awareness to that space that was not there before. Similarly, if we sit in an anechoic chamber, the closest to silence that we can get, we may begin to be in tune with our own bodily sounds in a new way. This is where the importance of sonic immersion comes into play. Through the expansion of sound into space and absorption back into body, our full state of being is engaged. I am talking about a type of immersion that is both a sort of constant sensory stimuli that we are also interacting with: an exchange between body and space. Sound is the glue that creates awareness of this linkage between inner and outer, between body and environment. The more multidimensional the sound is, the more dimensions in which we are engaged.

On a biological level, sound affects us. Charles Darwin wrote over a century ago about sound as an evolutionary necessity needed to trigger fight or flight response in times of danger. [8] (Darwin, 1872) In the daily sphere, sound evokes physiological, guttural, emotional responses to aid us in survival. It can invoke involuntary panic, anxiety, equivalent to a fight or flight response, it can move us to tears, or cause shivers down the spine. Though many studies have investigated music on a physiological level, not as many have investigated sound. [9]As it is clear that music can invoke these responses there has been debate as to what is the most significant trigger of these emotions. Is it rhythm, key, timbre, or pitch? Or is it more complex than that? Rhythm has been known to be one of the strongest contributors to emotional shifts, as we each are already instilled with bodily rhythms that affect our mood. When our brainwaves move at low frequencies, we become tired. When we run at a fast pace, our energy increases. When we hear a calm, soothing ambient song, a similar affect takes place, and when the tempo increases, so does our heart rate. Regardless of the specific results, one could say that no matter what the response, sound affects us bodily, and a whole network of experience is tied to this.

Sound can bring us to different states of conscious awareness and different subconscious levels. During a sound therapy session I once experienced the phenomenon of entrainment. A woman had a tuning bowl that is known to resonate at a frequency that centers our attention. In New York, everyone is coming from everywhere with a whole range

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[8] Darwin, one of the first figures to analyze sound in terms of biology, claims that it is an evolutionary necessity. It is not just a form of entertainment but part of ability to survive physically and emotionally as humans.

[9] Johnathan Slaboda did one of the first experiments attempting to assign different bodily responses to different emotions in music. A fairly raw first attempt at assessing people's emotional shifts, evaluated the physiological responses of people to different parts of a musical score.

of mental states but this one tone was able to all bring the whole room into nearly immediate focus.

Afterwards, we all verbally discussed how we were affected, and the majority of responses were the same: that as the tone resonated longer, our minds calmed and we began to feel an increased sense of unity with others in the room. I immediately became interested in entrainment. This phenomenon, which unifies our brainwaves to the same frequency, literally gets people on the same "wavelength," changing the frequency of an object near us to fall into sync with ours. I equate this sense of unification with getting outside of your individual body to be more in tune with another's and therefore being more connected to a larger human body. The self is lost. (Dyson, 2009) We all can share the same space through a sense of the dissolution of self and reunion with environment, a body and world blend and a sense of oneness can be achieved.

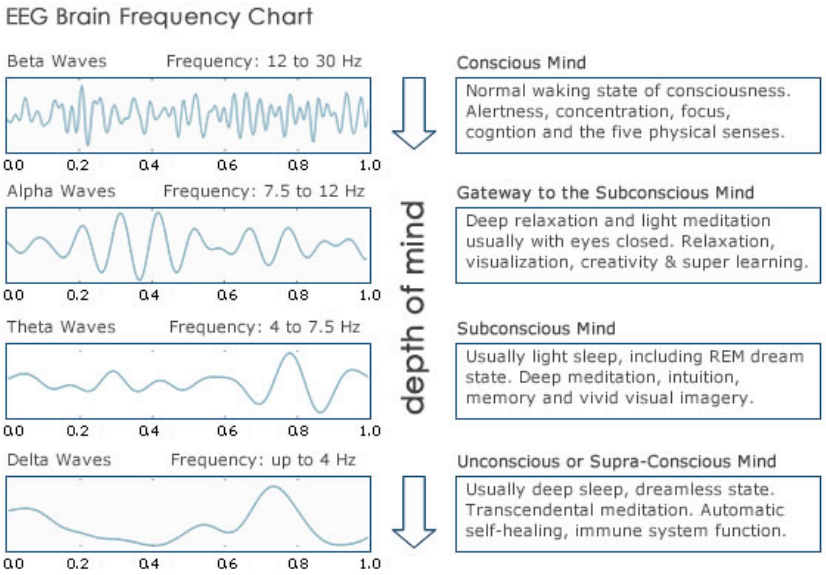

Figure 3

Most functioning of things in the world is based on rhythmic or cyclical movement. We are moving to circadian rhythms and functioning day to day at certain frequencies. Internally, our heart rate, breathing, and bodily processes are moving at a specific rhythm. As sound directly affects the body and brain, it is a good way to induce entrainment. It can bring our brain functioning to certain frequencies and therefore certain brain states. For

example, rhythm happening just below average heart rate, around sixty beats per minute will slow the brain waves to alpha waves and induce trance states. When the brain can detect phase differences or two slightly differentiated signals, a phenomenon called "binaural beats" occurs, inducing altered brain states. The result is the creation of a beat frequency which is the difference of the two signals, usually a subsonic tone. Below is an image of these different states, ranging from an "alert state" to a deep "subconscious" state. [10] The interesting thing is that entrainment is an "active" process of changing things around us to work closer to our frequency whereas resonance is more "passive," simply aligning an object to that of its own natural frequency.

Buddhist philosophy theorizes that we can become one with all that is around us by letting go of suffering and becoming aware of our larger connection to the universe. I believe that sound is a direct method of transport to reach a transcendent mental state. It is no surprise that music and sound facilitate a process of transcendence, but what element is it that initiates this process? Elongation of temporal perception? The social experience of being in the same sound-space with others? The specific frequencies that are triggered in the brain?

Magill illustrates that sound facilitates transcendence, lifts and inspires the human psyche to reach a multitude of domains simultaneously and be "transported" to other times and places. (Aldridge, 2006) [1] Similarly, with regards to the brain, there are baseline brain

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[10] Beta waves-from 14 to 20 represent our normal waking state of consciousness, a focused, attentive state. Alpha waves-from 8 to 13 hz and are associated with daydreaming or meditation. Closing the eyes makes them stronger. Theta waves-from 4 to 7 hz are found in states of high creativity and have been equated to states of consciousness found in much shamanic work or in deep meditation or sleep. Delta waves-from .5 to 3 hz occur in states of deep sleep or unconsciousness. Some of the newer brain wave work indicates that a state of deep meditation produces Delta waves in conscious individuals. Two other delineations of brain-wave activity have been noted by some researches: High Beta-from 23 to 33 hz are associated with hyperactivity, while K Complex-over 33 hz are associated with heightened creativity or moments of epiphany. (Goldman, 1989)

states or psychological sense of self and association of self with the body. An altered state is when our association with the body dissipates and we feel whole, unlimited, as if we are something larger. (Aldridge, 2000) It has been proven that activities such as meditation, music, dance, and even drugs are activities that break the train of sequential verbal thinking. It has also been known that musical sound can ease the sense of existential loss, enhance a sense of personhood and spiritual connection and sense of meaning. (Aldridge, 2000)

> Transcendence is the process in which humans move beyond the immediate time, place, circumstance, and transport to places and concepts of meaning, enlightenment, and inspiration. Aldridge states that as a process, transcendence is seen as taking us beyond our small selves, outside the everyday limitations of personality...to take an enlightened interest in others and the world through which we are led to greater knowledge and a greater capacity to love. (Aldridge, 2000, p. 38)

I've come to wonder what this transcendent experience is regarding sound. Some of it is brain states, and I think some of it is part social, or the sense of community in listening. When listening not with others, there is an exchange and expression of an inner, universal self by the artist that we all share as humans. Sound conveys a sense of presence without the creator or performer being there.

VI. Listening

"Listening is about giving the gift of time, the gift of our own mortality." -C. DeLaurenti

As a result of our current information age, it is often difficult to hear what is going on around us, much less listen to it. Listening becomes a process of the intentionality of hearing, hearing our environments but also our inner selves. What is going on in the resonant cavity of our own body? I believe the practice of different modes of listening can help us became more attuned to these things. Active listening activates the brain and instigates emotional and bodily vulnerability. Similar to the experience of the sublime, where you are looking at yourself in contrast to an abyss of wide open landscape filled with possibility, being immersed in sound engulfs us in a way in which we can surrender ourselves to something greater. Hearing in itself is full of possibility. We can never fully "close" our ears to our environment. Even when we are unaware of it, we are hearing. Listening is an active process of becoming aware of this fact, of becoming attentive to the information passing through our auditory cortex and throughout our bodies. As we become aware of what we hear, we can choose how to listen in a way that we can become more connected to others and our environments.

Oliveros (2005) talks about listening as an exchange between people and environments. She discusses "focal" and "global" attention throughout her Deep Listening practice. Similar to focal and global consciousness, focal attention describes paying attention to the details, limiting the span of our perception, whereas global attention describes opening and expanding of our attention to take in the whole of sound. (Oliveros, 2005, p. 13) Deep Listening is a way of listening that extends receptivity to the entire space/ time continuum of sound, calms the mind, and brings awareness to the body. It helps us become multi-dimensional listeners and think about listening from other angles beyond simply hearing with our ears. Oliveros ties the opening up to the universe of sounds to

having a deeper understanding of ones self, one's presence, one's relationship to their environment and to others. (Oliveros, 2005) Sound helps us make this connection, to be more empathetic and receptive.

Johnathan Cohen (2010) writes in his essay, *Sounds and Temporality* that "Sounds survive changes to their properties and qualities, determinate perceptible or sensible qualities, however, do not survive change in this way." (Cohen, p. 6) Slight mutability over time encourages a kind of interactive vulnerability, it gives listeners the time to absorb and to hear. Similarly, claims have been made that sound as opposed to music creates a sense of flux that opens up the doors to new dimensions of consciousness and transcendence.[11]

Eric Clarke, a music philosopher raises a philosophical perspective on how we listen, suggest that the way we think about an influx of auditory stimuli flowing into our bodies is unrealistic; that sound is in fact very physical, and we are part of a physical network where the brain is made to interact with sound rather than interpret it as something foreign. Another way to think of this might be new studies in the material sciences where materials are adaptable, and react to changes around them such as pressure, temperature etc., assuming a kind of unity between things. Clarke would go further to say that we don't in fact interpret sensory stimuli and then put it into schemas (this is a schema in itself); that experience is externally structured and we are part of a network of experience, literally shaped by all that we encounter.

Michel Chion also presents three different active listening modes: Causal, Semantic, and Reduced. Causal involves listening to sound in order to gather information about its

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[11] Christoph Cox presents a philosophical analysis of sound art, claiming that it opens up an auditory dimension of sound that music does not and describes how the concept of flux opens up the auditory unconsci ous as a transcendental state of being.

source, such as where it came from. Semantic has to do with representations involves listening to interpret a message or content. Chion's idea of reduced listening, which comes out of ideas that Pierre Schaeffer originated, has to do with focusing on elements or characteristics of a sound separate from content or meaning. While it is hard to impose listening methods on listeners or to avoid standardized methods of sound consumption, I am intrigued to suggest that we are becoming more capable of choosing the way we listen, both technologically and perceptually. Spatial sound practice, outside of standard sound consumption methods, opens up the space for and brings awareness to this possibility, perhaps suggesting ways in which we can use our sound sense to heighten daily experience, regain agency over our senses, and gain a felt sense of connection to the world.

Artistic Aims Essay

"Sound never entirely disappears. It dissipates. It relaxes, spreads out, becoming less and less contracted, but it remains hanging in the air, a breath away from silence, fused with the relaxation of every other sound that ever rang out. This noise of near-silence is an imperceptible background buzz, a vibratory limit of sound at which a sound rejoins all sound. Evans calls it a 'cosmic echo', a universal history of sound."
-Goddard, Halligan, and Hegarty

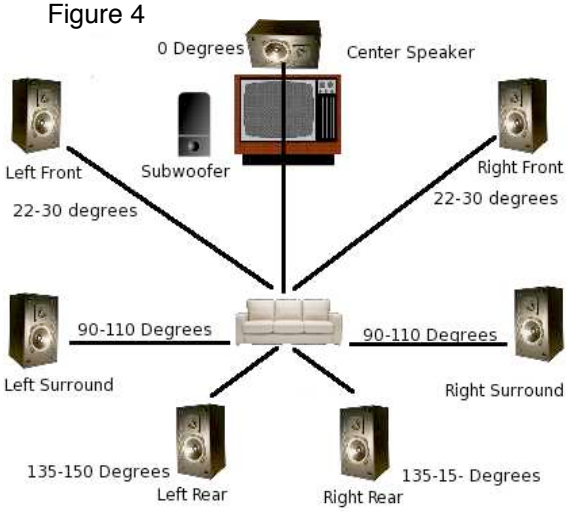
"The first concern of all music in one way or another is to shatter the indifference of hearing, the callousness of sensibility, to create that moment of solution we call poetry, our rigidity dissolved when we occur reborn--in a sense of hearing for the first time." -Lucia Dlugoszewski

I. Composition

Quantum Echoes is a sonic manifestation of the above theory and philosophy. A meta-composition of compositions, culminating into a soundscape, it compiles a variety of natural and synthesized sounds, musical and non-musical. Through its ethereal, amorphic,

otherworldly nature and expansion into space, the work defies the notion of linear composition and therefore linear time. Recordings were taken with very simple means: for example, one sound I recorded was a spoon hitting a glass. Creating something grandiose with minimal means is certainly a method that runs through my practice. The sounds of *Quantum Echoes* evoke a sense of other-worldliness through low drones, reverberation, metallic recordings, covering a spectrum of sound textures. It uses a handful of sounds that become relational, are always changing, but simultaneously recurring. [12](Juett, 2010) In the arrangement process, multidimensional composition is taken into account. This piece can be viewed as a soundscape, an installation, or a composition. It seeks to expand music composition into space and time, to rethink the canvas of sound presentation, especially in art spaces. The very way we think about composition affects the way we compose. If we are thinking in stereo, we compose in stereo. *Quantum Echoes* explores how to think about sound in 3 or even 4 dimensions as early as the composition stage, and how we can become physically, emotionally, symbolically, and viscerally engaged with art without an explicit statement. Through positioning, active consideration of space, various filtering effects, longevity, and immersiveness, *Quantum Echoes* brings us to different states of consciousness.

Figure 4



7.1 Channel Surround System

[12] Ki Mantle Hood's theories of quantum composition arise in Oliveros's practice. In the late 90s, he proposed that using partials such as pitch or volume that become relational, are always changing, but simultaneously recurring. (Juett, 2010)

II. Environment

In a dimly lit rectangular space, 12 tracks in Ableton Live are routed through 7.1 surround sound, or 8 channels (2 front and back channels, 3 side channels, and a subwoofer). It creates a psychological and physical space that is void of any visual stimuli other than speakers, speaker stands, chairs, and the room itself. The intention is to have a semi-reverberant room in a somewhat isolated space that gives us room to safely reflect. Though I am interested in the notion of "interactivity", the listener only truly "affects" the piece by the way they interact and listen. Some have moved around the space, some have sat in various chairs for a prolonged time, and some have staying in one seat for an entire hour. Though one may be affected simply by coming into the room for a short time, any noticeable effects in mental state may take time to occur.

Through its spatial immersion and its generative, ongoing composition, *Quantum Echoes* challenges the nature of passive listening. It first de-objectifies sound through re-orienting the listeners' attention to the loudspeakers and the room itself rather than a select performer. Secondly, it encourages the act of "walking through" to explore it at various positions. Though the listener is immersed, he/she has to do work to discover the work. (Dyson, 2009) Between the scattered placement of the chairs and the movement of the sounds from one speaker to another people are encouraged to listen from multiple perspectives. No one position sounds the same and new nuances can be discovered. Through this sort of discovery, sound experience becomes physically and psychologically active, presenting a new way of engaging with sounds around us. (Dyson, 2009)

III. Motives

The main motive of this piece is to transport the listener to another mental or physical state. This of course will be subjective depending on individual experience, but I hope if anything, the piece is able to shift the listeners mental state, perception of environment, create mental imagery, or sense of the eternal through sound. From this I hope the listener can gain a sense that they are an active agent of their perception and be more intentional in choosing how they listen. We must realize that though we may not see an immediate connection to the things around us, we can be if we put our mind in that place. I hope not to create a passive experience, but to intentionally create sounds that instigate this kind of immediate connection with both environment and inner self. One may hear the soundscape for its aesthetics, but I hope that it goes deeper than that. The motives of this piece are somewhat altruistic, as I hope it brings people to a more "universal" or "transcendent" state without of course denying their own subjective, positioned experience. How can immersive sound experiences induce a felt, holistic, self-conscious awareness that we can bring with us into our daily lives? How can sound be more than an aesthetic experience, but a tool for attuning ourselves to our bodies and our environments? In creating a soundscape versus a timed performance or composition, the blur between subject and object, self and environment is enhanced.

IV. Influences

As referenced earlier, *Quantum Echoes* uses Stockhausen's method of moment formed composition, or the idea that all things are occurring in every moment, though things come and go, ideas evolve and relax, but virtually nothing changes in the grand

scheme of the piece. Similar to white noise, each moment of sound is full, or a composition in itself, like a film technique where each shot is a complete photographic moment. Another main compositional influence for this piece is Steve Reich's "gradual process" music that is about leaving musical happenings up to chance, putting in place certain recurring themes, but letting them unfold over time naturally. Similarly, I put the Cagean ideas of chance composition where he refrains from making relationships between sounds, but instead acknowledging that that sounds already have a complex relationship into play. (Cox & Warner, 2009) Though I do take some agency in the making of *Quantum Echoes*, I do allow for the composition to be open to unplanned changes through random placement. Once put into place, I allow relationships between sounds to evolve naturally. Integrating Oliveros's practice of listening into the making, the piece works in multiple dimensions. Instead of composing by constructing lines and parts that have a beginning, middle, and end, it takes into account complex relations between the sound events that are recurring simultaneously in space and how this can expand our mind to hear in many dimensions at once. Often the process of going about the world, we do not realize the content and history of what we are experiencing. As the piece verges between extremes: clear, distinct sounds and more distant, reverberant tones, I hope the piece dismantles our modes of listening.

As there are a variety of Sound Art practices, as mentioned earlier, the installation's multi-channel nature is what distinguishes it from being a "sound object" and brings it to being "a sonic event": a method of displacing sound throughout physical space. As noted in my Background essay, the notion of embodiment has become a prominent trend in Sound Art practice. Similar to the Minimalist art movement that refocused our attention from objects to perception, space, and time, I believe Sound Art is taking on that role in the

current day. Many art worlds are currently bursting with new modes of emerging sound practice and awareness. Here I will cover a range of pieces that have in some way influenced the making of *Quantum Echoes*.

The most influential piece in terms of spatial, multichannel set-up for this work is Janet Cardiff's *40 Part Motet*. At the Cloisters Museum and various locations internationally, Janet Cardiff arranged 40 speakers in a circular shape around a room, each playing a unique voice in the motet. Sometimes shown in a church, sometimes in a gallery, the exhibition has travelled internationally. One is surrounded by a seemingly real choir, and the result is an immersive, psychological musical experience without the presence of actual bodies. It veers us towards the sound of the pure voice and the internal cavity it reverberates through. In contrast, I'm trying to create a unified soundscape rather than having speakers exude different human "personas," but this idea of a relational exchange between the technology itself and the sound coming out of it is applicable. As she attempts to "humanize" the speakers through vocal sound and vocal expression, I am also to some extent trying to "humanize" technology, to create the effect of presence when actual presence is not in fact there.

James Turrell, an artist who primarily transforms space with light installations, has similar ideas about highlighting space and architecture through light and using sensory phenomena to activate viewers' perception. His immersive, architectural installations use light to change the viewer's experience of space. However, I feel the result is sometimes that viewers get more caught up the aesthetics of the light or even the social spectacle of these works than how it is actually shifting their perception. In turn, I attempt to create a somewhat private environment for *Quantum Echoes* and a direct, physical interaction with

space that is not limited by vision. As sound allows its content to be rather transparently present in the body, and therefore is less likely to merely reveal its aesthetics.

An older piece that is highly influential in and still viewable in New York City and has been for 20-so years, is La Monte Young's *Dream House* installation. The fact that this installation has been on view for over 20 years and has no finite sense of duration illustrates this notion of time-based work creating space, meaning it can shift over time or it can compress or expand our conception of time, which in turn puts us inside a morphed sense of reality. The piece blasts low frequency drones from large subwoofers using the physical experience of sub-bass tones to extend our experience of sound in space. Coming out of it, one feels the positioning of the head in relation to the sound space through differences in pitch. The physicality of the sound begins to become apparent upon leaving the dense vibrations as if emerging out of a swimming pool. As sense of body is heightened with the sound of the subwoofer, I specifically referenced the low drones of Young's installation to create a thickness in my piece. Initially, I had focused mostly on high frequency sounds and when I added low and low-mid drones, it did help to increase the physical experience of the sound.

A way that I think is helpful to think about sound's presence is in terms of architecture. James Turrell said on a label at his most recent Guggenheim exhibit, *Aten Reign*, "When you walk into a room, space is just there as if it was waiting for you." Sound is very much the same. Our ears are always open to it, but we are not always listening. To think about sound in terms of how it fills a room, how it reflects off of surfaces, how it transduces from mechanical to electrical energy instead of just being something that comes into our ears so that we can hear it. Sound is about vibrations, physicality, feeling the bass through

the floor, letting low frequencies engulf our head and fast frequencies get lost in our heads. Sound is both physics and psychoacoustic; how we feel it physically and how we perceive it.

Recently, MOMA has implemented one of the first self-aware institutional Sound Art exhibits in New York (and probably the US): "Soundings: A Contemporary Score". It incorporated a variety of sound art practices, a few of them including spatialization of sound with multi-channel set-ups. *Microtonal Wall*, by Tristan Perich presents a wall of 1500 small speakers arranged in a grid that burst with different microtones. Perich has explained, "Each listener's exploration of that aural space shapes what they hear, from the totality of white noise (from a distance), to the single frequency of each speaker (up close)." I draw on his notion of a set-up where having speakers embedded into the existing architecture of a space is a way to shape psychoacoustic experience without saying "here's an art piece." By placing sound technology within the reality of daily space, listeners can easily "take with them" a sonic awareness of the space that they did not previously have. My installations under public bridges and in objects like tree stumps or garbage cans work with this idea.

Works that have less directly influenced *Quantum Echoes* are Susan Phillipz's *Study for Strings*, played on 8-channels is a contemporary interpretation of an orchestral work by composer Pavel Haas, that he wrote while imprisoned in a concentration camp that during the Holocaust. It presents only the string parts of those who survived and highlights the absence of those who passed through silence. For me, this explores some of the emotional connections between sound and memory, creating a sense of loss through the heard. Steven Vitiello's *A Bell for Every Minute* was a piece done in 2010 that used a 59 recorded bell sounds from various locations around New York and then synchronized into one bell tone that rings at the top of the hour. Similar to Quantum Echoes is the idea of collecting sound

from a variety of locations and synchronizing them. This acts as a physical manifestation of the process of entrainment, or the joining of disparate sound events into a unified sound event. Jana Winderen presented her piece, *Ultrafield*, which was presented as a 16-channel ambisonic installation, as to reproduce the actual environment of remote locations around the world, focusing on frequencies heard above the human hearing range and pitched down so that they could be heard in one soundscape. More focused on direct recreation of an environment than *Quantum Echoes,* this installation brings the listener into the original environment of the sound, therefore displacing that environment into a museum setting.

V. Design

Psychoacoustic experience was taken into account in the design of this piece. Various psychoacoustic and acoustic effects come to life in this installation, particularly localization and distance perception, localization being most important for identifying the source of a sound and distance perception in creating a sense of space and depth. Though *Quantum Echoes* is not trying to replicate an actual environment, it considers how room reflections and reverberation will create a sense of distance and delocalization of sound while contrasting that with, intense, pointed, higher-frequency tones. It uses low frequency tones to bring a sense of body into the experience, rather than just using higher frequency tones that sound close to the head. Having a large range of feeling like the sounds are near the head, moving past you, or far away increases the psychoacoustic space in which the listener can travel. Familiarity comes into play as it points at familiar sounds but does not replicate them exactly, giving the listener some ability to relate but still creating a sense of ambiguity

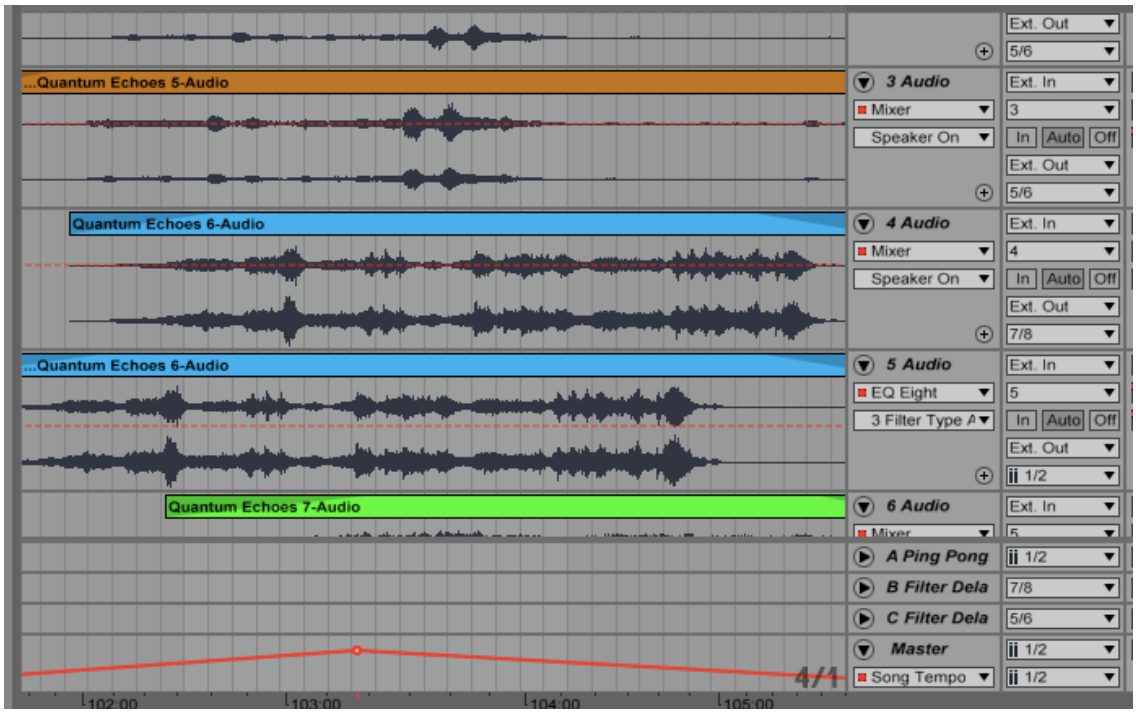


Figure 5

and subjective interpretation. Both virtual reverberation and physical reverberation affect distance perception in creating a sense of space that the room does not actually contain. Having no visual stimuli to evoke the ventriloquism effect was important. It was important that the listener just focus on the sound in near darkness as to not be distracted by the visual source. When eyes are closed, this psychoacoustic sense is enhanced.

Though this piece uses specific sound content, I also think about the piece acts as an artist approach or infrastructure. This method can be used to think about electronic composition in a new way: as both vertical spatial layers and horizontally progressing in time. In any moment of this composition, the snippet would be different, yet virtually the same.

Technical Essay

I. Process

Over time, sound has become commodified, privatized, idealized, collectivized for the pleasure of bourgeois culture. (Sterne, 2003) Sound reproduction technology has promoted the idea of "listening alone, together," segmenting acoustic space, mediating certain social behaviors within listening environments. (Sterne, 2003) It explores the idea of community in a post modern sense, the experience of being with other people but not interacting, or embodying a very private, intimate experience with others in public.

The piece also investigates a technological infrastructure for sound art that is hard to find in art galleries and institutions. As this sort of set-up is hard to find in galleries and institutions, and hard to foster in uncontrolled environments, Harvestworks is one venue that specifically promotes this setup. What I've found doing installations in uncontrolled settings is that it creates a focused environment for the listener and limits the number of factors in hindering one's ability to perceive the sound. By having *Quantum Echoes* in a smaller, intimate, somewhat neutral room environment, I can somewhat isolate it from the work of these visually oriented institutions. The work is composed so that what Certeau states as "the discovery of sound" is possible, changing, and continually present. (Born, 2006) The sound is composed with this in mind, as to create the effect of one sound shifting from one speaker to another. Instead of the listener being able to only localize sound from one source, they can hear and feel it from all different directions as we do in daily experience. It looks at the relations between things rather than things in themselves: the relations between sound and space, sound and time, sound and body, and the relationships between the sounds themselves. (Born, 2006)

Quantum Echoes explores this range of listening possibilities through intentional variations in frequency, delay, reverberation, EQ, and speed as to reach a spectrum of distance and time perception. Aux sends are used to give the sense that the sounds are moving from one speaker to the next. By having the dry signal coming from one speaker and the delay sent to other speakers, it gives the illusion of an after-affect and in turn further connects the sounds to one another and themselves within the larger mix. With the prominence of electroacoustic media and the rise of recording and expansion of presentation methods, presenting "past" information in time has become more possible. (Traux, 2000)

My first concern in the composition was creating a sense of space. As mentioned before in the "Perception" section, if people can hear the range of closeness to range of being far away, there is space in between to move. If there is no psychoacoustic time difference, we only can detect certain frequencies. I hope to expand the range of frequencies that we can perceive. Similarly, I also create intentional tonal and timbral ranges, thinking about how more pointed sounds might be more isolated and more droney sounds might be more blended. Putting delay sends onto different versions of the same sound, and then spacing them across from each other gives the illusion of coherence, so that sounds are not only just coming out of individual speakers, but they are somehow related and "interacting" with each other. There was constant adjustment between the sounds in my head, the stereo mix, the multichannel sound environment in the research lab, and finally the space at Harvestworks.

As this piece was composed in a research lab and later presented in a room at Harvestworks, various things differed: the dimensions of the space, the types of speakers,

the speaker placement, the room reflections, the insulation/fabrics in the rooms. I found strength in the heightened reverberant nature of the Harvestworks room, the wood floors and drywall walls helped integrate the sound into the space and take on the characteristics of that space enhancing spatial awareness for the listener. The seven large speakers placed at about head height and the one subwoofer I found to be slightly less precise in terms of ability to localize but gave more fullness/body to the sounds.

At various points I got critique, and adjusted the soundscape composition. One main point of focus was keeping coherency between the sounds and sense of unification in the space. By sending delays to channels, and having them replicate in different positions, the speakers became less definable as the source of the sound and began talking to each other. Another point, was the density of the sound. At points, I adjusted layers, took parts out and shifted sound volume. I also added more low frequency parts as to increase sense of bodily immersion. The last main adjustment evolving tempo shifts 60 bpm (average heartrate) and 120 bpm as to ease the listener into different mental states. I think with the acoustics of the Harvestworks room, all of these compositional changes were really enhanced in a more reverberant, larger spatial environment.

Figure 6

Figure 7

II. Feedback

Accompanying the piece was a series of voluntary questions that I left for people to fill out about their experiences surrounding my interests in perception and listening in the art context. I prefaced the questions with the below blurb about the piece and the knowledge that general findings might be reported in my thesis paper:

"Quantum Echoes" is a 7.1 surround sound environment, a meta-composition of compositions, synchronized, filtered, and spatialized. It considers the relational nature of sound itself, deconstructing sense of time, seeping into spaces removed from the guise of the visual or the material, where content is reaching for something beyond singular, discernible narrative or melody and reflects back on the listener for embodied, positioned listening and active perception. One is brought to an other-worldy place through a variety of natural and synthesized sounds intertwining and evolving with one another. The piece references (further explained in the written thesis) thinkers/ composers/artists such as Cage, Xenakis, Stockhausen, Reich, Oliveros, Jung, Borges, Cardiff, Philipsz amongst many others who embrace multi-dimensional notions of time and actively use chance as a compositional process."

1) Did the sound make you more attentive to your environment in any particular way? Describe how or how not.
2) How did this sound experience differ from daily hearing?
3) How did the installation experience differ from watching live music?
4) Was your sense of time and space affected? To what extent was it the sound itself that triggered this or the space it was in?
5) Was your state of mind affected? Did it induce any sort of trance-like or meditative states?

6) Please describe your overall experience.

I had many responses that spoke about the difference in hearing without visual stimuli. Many people naturally closed their eyes to experience the space and found that the soundscape destabilized their sense of time and space more so this way. Being in the dark or closing the eyes was fundamental to fully experiencing the effects of the sound. Many spoke of an initial hyper-attentiveness, even anxious response to their environment, that morphed into a more peaceful, meditative state as they spent time in the environment and adjusted to the sound. Many talked about becoming more inwardly focused as time went on, describing internal shift in mental states, such as dream sequences, scenic imagery, cinematic experience, a sense of loneliness or being with one's self. Any shift in immediate time perception was initiated by following the movement of the sounds, while the overall sense of time was generally absent, and as a result, people stayed in the installation longer than they realized.

What made this different from watching live music for many was both in the nature of music and performance, following a melodic or linear musical form differed from the multi-dimensional sound design of this installation, while the lack of watching or getting energy from a performer made one withdraw more into their minds than experience a physical, social space. Some had an experience of psychoacoustic confusion because of all of the contrasting layers happening at once. While both dynamic and high frequency were happening, so were more subdued low frequency things, creating a dense stream of stimuli. It then became a matter of preference, perhaps, as to what one would focus on. As some

took it as a positive trait to open up composition to this complexity of sounds, others found it disorienting.

Many stated that the piece differed from daily hearing in that it made them more aware of their listening and the fact that they could change it. There was also an ambiguity as to what one should do in the space. This forced many listeners to take more agency in how they experienced the space. They reported that position in the room or even whether you stood, sat, or lie down on the floor affected their experience. Lying down was perhaps the most beneficial way to really get into the space, though many said they could fall asleep if they listened long enough.

Their sense of space increased and even shifted with the sound. I found less comments about time shifting and more about not actively thinking about time; in other words, a person could just "be" in the moment. Some experienced the feeling of being "transported" in time and some did not. The transporting that occurred seemed to have to do mostly with shifting mental imagery triggered by the sound. Being transported from a desert to space to being in a cyclone, but a few did mention being physically transported in their orientation to the room. Though a few found this anxiety invoking, a handful of people found it specifically therapeutic, as if they were undergoing some sort of healing process as they spent time in the space.

Anonymous Quotes on the Soundscape:

"In contrast to a visual art gallery, this expo has 7.1 pieces. The context of the visual art lends only partially. You can't sense more than one painting, sculpture... at a time. Here, you can truly experience the art in context. The environment forces itself on you at all points of perception."

"I went in without knowing what to expect. Sat and immediately felt transported in space. When I opened my eyes, it didn't match that the room was so small and the speakers were responsible. Furthermore, great wall of sound, strong soundscape, unless I was standing by a speaker, the sound was surrounding, immersive and enveloping."

"When I had my eyes open, it didn't feel so great. When I closed my eyes, I felt more immersed in it. Kinda like being in the depths of space. Some parts were intense and frightening, others were tender and gentle. I liked the movements the sound made forward and backward, one side to the other, massaging my brain and playing with my hair."

"Because the sound had such a strong sense of movement, I became more sensitized to the space and felt my consciousness/awareness moving through the space, following the sound. The movement created a hyperspace in my imagination."

"I felt a broad sense of shifting, decentering. And trying to trace, it felt elusive. I felt that some of the high frequency transients and flutters evoked a sense of desire to entrain and elevated my heart rate."

"It was a unique experience to be moved through visualizations of scenes to a relaxing meditative type of state. You lost sense of time due to the continuity and ever changing sound progression. The variety of sound enticed you to keep listening without regard to time."

"It made me more attentive to my body than to the space. I felt I consciously had to use my whole body to listen. Experienced a sense of levitation and circular upward motion, between sleeping and waking. I moved between real immersion and struggling with my own thoughts. It was hard to be present but the space felt very dynamic and safe at the same time. At points I heard sounds I recognized and I felt resistant to the intrusion of daily life into magical space."

"I was aware that I was listening. Even when I listen to music, I'm not always aware of my listening. It made me realize how important awareness of our senses is."

"Kind of nice. Swirling. Like a slow cyclone picking up the world around you & slowly breaking it & smashing the pieces against themselves.. But lonely. And heavy. And with a choo choo train that is going to hit you but then doesn't & leaves you when you wish it would carry you home."

Conclusion

In conclusion, this project has allowed me to straddle the lines between art and research. It has helped me discover things organically, but mostly has left me with questions. To what extent can sound art be used to study responses to sound in a real life context and how can it be integrated into daily space without limiting its technological presentation? I have been able to investigate how the art context can provide an environment where people feel safe to reflect. I hope that in the future I will be able to design these sorts of experiences to facilitate sound research that is not removed from space, site, or social context.

This project has also advanced my ideas on spatial composition. How can we integrate the idea of spatial placement in the creation phase and use chance to our advantage? Whether putting in place a set of rules before hand or structurally placing things randomly, how can we be more intentional in using chance, while leaving room to let things evolve naturally? Also, what is the content that we're putting into the sound design and how can this be understood abstractly? We often associate sounds with very literal representations of things, but how can we understand it in its complexity? It has made me realize that if well thought out enough in the compositional phase, all of these concepts can be conveyed directly through the sound itself. If we think about sound composition as an energy transfer, as I am putting anxious or meditative energy into a piece, it will exist in the sound. I am interested in this abstract communicative ability that sound has, and its ability to convey very complex information directly and forwardly, so that I as an artist don't have to tell someone what to feel, they will be able to find that in the work if they are willing to listen. Sound can teach us a lot about the substance that exists beyond the visual, and the

sense of connection and presence it can provide, connecting us back to more primal, ritualistic, even biological realms of existence, to our environments, to other people and the source of our being.

References

Aiello, R. (1994). Can Listening to Music Be Experimentally Studied? *Musical Perceptions.* New York, NY: Oxford University Press.

Aldridge & Fachner. (2005) *Music and Altered States: Consciousness, Transcendence, Therapy and Addictions.* Jessica Kingsley Publishers.

Arnheim, R. (1954/1974). *Art and Visual Perception: A Psychology of the Creative Eye.* Berkeley and Los Angeles: University of California Press.

Arnheim, R. (1971). *Entropy and Art*. Berkley, CA: University of California Press, 1-35.

Augoyard & Torgue (2006). *Sonic Experience*. Ontario, Canada: Queens University Press.

Bamberger, J. (1978-86). Coming to Hear in a New Way. *Musical Perceptions*. New York, NY: Oxford University Press 131-151.

Bates, E. (2009). *The Composition and Performance of Spatial Music*. Dublin: University of Dublin.

Borges, J.L. *A New Refutation of Time*.

Born, G. (2013). *Music, Sound, and Space*. Cambridge, UK: Cambridge University Press.

Chadabe, J. (1997) *Electric Sound*. New York, NY: ICON Group International.

Cohen, J. (2010). Sounds and temporality. *Oxford Studies in Metaphysics,* 5.

Cox, C. (2006). From Music to Sound: Being as Time in the Sonic Arts. *Sonambiente*, Berlin: *Klang Kunst Sound Art*, ed. Helga de la Motte-Haber, Matthias Osterwold, Georg Weckwerth (Heidelberg: Kehrer Verlag, 2006), pp. 214–23.

Cox, C. (2009). Sound Art and the Sonic Unconscious. *Cambridge Journal: Organised Sound* 14 (1): 19–26.

Cox, C. & Warner, D.. (2004). *Audio Culture: Readings in Modern Music.* Bloomsbury Academic: New York, NY.

Darwin, C. (1872). *The Expression of the Emotions in Man and Animals*, London: John Murray. 1st edition.

Duckworth, W. (1999). *Talking Music: Conversations with John Cage, Philip Glass, Laurie An derson, and Five Generations of American Experimental Composers*: First Da Cappo Press, 3-28.

Dyson, F. (2009). *Sounding New Media.* Oakland, CA: University of California Press.

Edelman, Fekete, & Zach. (2012). *Being in Time: Dynamical Models of Phenomenal Experience*. John Benjamins Publishing Company. 1-4, 17-18, 155-156.

Goddard, Halligan, and Hegarty. (2012). *Reverberations: the Philosophy, aesthetics, and politics of noise*. New York, NY: Continuum International Publishing Group. 46.

Goldman, J. (1989). *Sonic Entrainment*, from Johnathan Goldman's Healing Sounds. Retrieved March 23 2014, from http://www.healingsounds.com/sonic-entrainment.

Horowitz, S. (2013). *The Universal Sense: How Hearing Shapes the Mind*. New York, NY: Bloomsbury Publishing.

Huron, D. (2006). *Sweet Anticipation : Music and the Psychology of Expectation*, Cambridge, MA: MIT Press.

Iges, J. (2000). *Soundscapes: A Historical Approach.* Montreal: CEC.

Juett, J. (2010). Pauline Oliveros and Quantum Sound. *Liminalities*, Vol. 6, Issue 2., 1-2, 4, 6-7.

Kane, B. (2007) L'Objet Sonore Maintenant: Pierre Schaeffer, sound objects and the phenomenological reduction. *Organised Sound.* Jan 20, 2003.

Kivy, P. (1980). *The Corded Shell: Reflections on Musical Expression.* Princeton, NJ: Princeton University Press.

Kendall, G. (1995). A 3-D Sound Primer: Directional Hearing and Stereo Reproduction, *Computer Music Journal*, pp. 23-46.

Licht, A. (2007). *Sound Art: Beyond Music, Between Categories.* New York, NY: Rizzoli International Publications.

McTaggart, J. Ellis (1908). *The Unreality of Time*. Oxford University Press. 457-474.

Merleau-Ponty, M. (1945). The Phenomenology of Perception, trans. C. Smith. London: Routledge & Kegan Paul, 1962.

Oliveros, P. (2005). *Deep Listening: A Composer's Sound Practice.* New York, NY: iUniverse, Inc.

Pulkki, V. (1997). *Virtual Sound Source Positioning Using Vector Based Amplitude Panning*, J. Audio Eng. Society., Vol 45, No. 6, June, 1997 Society Convention Paper 7959, 127th Convention, October 9-12, 2009.

Pulkki, V. (2001). Localization of Amplitude-Panned Virtual Sources II: Two-and Three-Dimensional Panning, J. Audio Eng. Soc., Vol 49, No. 9, September, 2001.

Richards, S. (1996). *John Cage As....* Oxford, UK: Amber Lane Press Ltd.

Sacks, O. (2007). *Musicophilia*. New York, NY: Vintage Books: Randomhouse Publishing Inc.

Schafer, R. Murray. (1993). *The Soundscape.* Destiny Books, Rochester, VT.

Slaboda, J. (1991). Music Structure and Emotional Response: Some Empirical Findings: *Psychology of Music.*, University of Keele, UK.

Sterne, J. (2003). *The Audible Past*, Duke University Press. 167, 177.

Truax, B. (2000). *Acoustic Communication (2nd Edition)* Santa Barbara, CA: ABC-CLIO.

Winckel, F. (1967). *Music, Sound, and Sensation*. New York, NY: Dover Publications Inc.

Voegelin, S. (2010). *Listening to Noise and Silence: Toward a Philosophy of Sound Art*. London, UK: Continuum International Publishing.

Zahorik, P. (2002). *Auditory Display of Sound Source Distance.* Madison, WI: University of Wisconsin.

MoMA (2013). *Soundings Exhibition Artists*. March 1 2014, from http://www.moma.org/interactives/exhibitions/2013/soundings/artists/

Images

[Figure 1] Truax, Barry. (2000) *Acoustic Communication (2nd Edition).* Santa Barbara, CA: ABC-CLIO

[Figure 2] Undesired energy forms (system losses). Retrieved April 4 2014, from http://www.emersonindustrial.com/

[Figure 3] EEG Brain Frequency Chart. Retrieved March 23 2014, from http://deepakgoyal1985.blogspot.com/2012/05/explore-brain-waves-potential-of.html

[Figure 4] 7.1 Channel Surround System. Retrieved April 4 2014, from http://4homecontrol.com/glossary#7.1

[Figure 5] Screen shot of Ableton Live session. May 15 2014.

[Figure 6] Image from installation opening. Harvestworks, March 28 2014.

[Figure 7] Image from installation opening. Harvestworks, March 28th 2014.