Acoustic Mirage: A Psychoacoustic Sound Installation

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Supplemental materials related to this article are available at <www.ellenband.com>.

ABSTRACT

The author describes her creation of a sound installation inspired by the phenomenon of auditory hallucinations.

Acoustic Mirage invites the listener to enter a uniquely designed sonic environment in which the boundary between aural reality and aural fantasy is dissolved. Moving through a dense noisescape intended to provoke and entice the ear, participants confront a perceptual dilemma—are they really hearing what they think they are hearing?

This installation simulates the psychoacoustic phenomenon of auditory hallucinations—i.e. hearing voices and music that are perceived to be present, but actually are not. Inspired by personal experiences of acoustic hallucinations created by combinations of simultaneously sounding pink noise–generating motors in various spatial relationships, this piece explores auditory imagery resulting from what might be termed "combination noise."

Acoustic Mirage was inspired by and simulates an experience I had of hearing "voices" within a dense bed of machine-generated noise. While observing this phenomenon, I noticed that the voices would appear or disappear when my head and ear orientation shifted slightly. Intrigued by this experience, I set out to understand the phenomenon. I subsequently learned that many people in various situations, such as standing near a waterfall, encounter this acoustic phenomenon when hearing noise or layers of random frequencies. These perceptions are referred to as auditory hallucinations and are almost always perceived as voices and/or music. But is this an illusion or the brain's need to organize and make sense out of acoustic chaos? Psychoacoustics, the branch of science that studies the perception and processing of sound as well as its effects on physiology, deals with this question.

Once I learned of auditory hallucinations, I knew I wanted to create a sound installation that would present acoustically fertile conditions for experiencing this phenomenon. My initial thoughts about designing a sound installation came from a visual analogue. I had seen a movie many years ago titled *Under Ten Flags* [1]. There is a scene in the movie in which a spy has to break into a safe containing documents he has to photograph. The hitch is that the room is protected by an alarm system that is a complex web of light sensors. He is given a pair of glasses that allow him to see this web. Watching him climb through this web of invisible light was a movie moment I have never forgotten. Using this visual image, I conceived of an acoustic web of noise that would contain sonic "hot spots." These hot spots would be points at which intersecting frequencies produce aural hallucinations similar to the one I experienced.

After some discussion with colleagues, I abandoned this idea and decided to re-create the phenomenon through simulation. I made two tracks that are dense beds of noise constructed from recordings of various machinery. The third track is a recording of "subliminal audio suggestions," or what psychologist and psychoacoustician Albert Bregman terms "assisted perceptions" [2]. The subliminal track consists of words and music embedded within the pulsating mixes of discrete noise-generating devices. This track is played back at a low level, or "threshold" level, giving it a subliminal presence.

Upon entering this installation, visitors may initially apprehend the noise fields simply as pink or white noise. As the sound continues to subtly morph, revealing a more complex nature containing other sonic information, details and imagery, people can create personalized acoustic imagery by slowly moving through the acoustic web, identifying their own sonic "g" spots. As in an interactive installation, audience members enter as listeners but can become active participants. Through selectively focusing on combinations of noises and sounds within the sonic fabric of the installation, visitors can create personalized acoustic imagery partially determined by their own interface between sound and physiology. When listeners spend enough time with the installation (individual for each person) they usually begin to hear their own hallucinations, thereby creating the effect for themselves.

Acoustic Mirage has been featured at several festivals and sound galleries [3].

References

1. *Under Ten Flags* is a 1960 Italian-American war film directed by Duilio Coletti. See <en.wikipedia.org/wiki/Under_Ten_Flags>.

2. A. Bregman, *Auditory Scene Analysis: The Perceptual Organization of Sound* (Cambridge: MIT Press, 1994).

3. Two comments from the sign-in book lend credence to the installation's success at recreating the phenomenon:

"Your installation has given me clarity and crystallization. I now know what happened to me 18 years ago when I woke up at 3:00 AM to the distinct sound of human voices. I'm not as cracked as I thought. Thanks."—DB, California

"Stumbled on your Acoustic Mirage. Sandra (10 years old) thought it was just a bunch of noise. Susan (her mom) appreciated that 'a bunch of noise' is beautiful. I appreciate the children singing."—Susan, Ontario, Canada. (Author's note: There is no recording of children singing in the subliminal audio suggestions. This comment is an example of the participant generating her own audio imagery—her own aural hallucinations.)

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Sound artist and composer Ellen Band creates solo and collaborative works for performance, sound installation and sound sculpture. She performs in numerous venues in the U.S.A., Canada, Europe and Israel, and has presented sound installations at Boston's Logan International Airport, festivals such as the Sound Symposium and SoundCulture 96. She is the founder and director of Audible Visions, a sound and music series in her Somerville, MA, loft.

Sustained Tones and the Auditory Experience

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ABSTRACT

The author describes his approach to using sustained tones in his compositional work and how he harnesses acoustical and psychoacoustical occurrences to create individual listening experiences.

For me, the sustained tone represents the base in music. It provides us with a unique experience whereupon expectancies, imaginations and temporalities can be flexible and entirely individual.

What can be gained from sustained tones, deviating in pitch or not, is a much-enhanced appreciation of the effects of sound on our auditory systems and our being as a whole. Sustained

tones provide open, non-hierarchical surface layers where much acoustical phenomena occur and where our psychoacoustical processes attempt to deal with data that prove hard to compute.

When I come up with new ideas for a sounding composition, I usually conceive of it in terms of how little or how much the composed parameters will deviate from a continuously sustained tone or tones. For deviation to occur there must be an absolutely explicit reason; deviation for the sake of contrast is, for me, a tedious approach toward artistic creativity. What interests me in composing is extremely gradual, linear pitch movement that does not draw attention to the act of deviation but rather continues to present environments where we focus upon an active surface layer.

I use simple convergent or divergent pitch structures, similar to those used by composers such as Phill Niblock and Peter Adriaansz, to create evolving environments for these acoustic surface layers. In my piece *Gradual Music* for small ensemble, pitch clusters gradually ebb and flow ever wider before narrowing back to their beginning points, allowing varying layers of events to occur throughout.

These acoustical and psychoacoustical occurrences form a significant part of my compositional materials. Above all, it is the generation of beating tones in the surface layer that interests me, where amplitudinal variation is created from interference between two tones in close frequential proximity. Very gradual pitch movement generates gradual transformation in the beating patterns, as a result of the action of the instrumentalists, but not always intended by them. Multiple layers of beating patterns create dense webs of transforming sound; our perceptual systems cannot easily partition these simultaneous layers into separate streams, so they become blurred together in different ways for each listener.

In addition, the close tone clusters become difficult to parse into single tones until pitch intervals expand past the critical band; however, individual perceptual systems interpret this differently, resulting in widely contrasting individual experiences as clusters form and dissipate uniquely in individual auditory systems. It is this fuzziness in perception that intrigues me: There is not one single ideal of what my music may be like, but each participant experiences it in a singular manner.

The reason I choose to realize these ideas of gradual transformation in sustained tone environments in a live, instrumental scenario, rather than using electronics, is to promote the personal, physical nature of the music. Over extended-duration sustained tones, human performers naturally deviate in pitch, dynamic, bow/lip pressure and so forth, which results in changes in the surface layer of the sound, consequently affecting our perceptual experience of the music. The nature of human fallibility in this respect is celebrated within the music in its relation to the indeterminate effect upon the acoustics of the sound.

Many more things remain to be explored within sustained tone environments, and the nature of acoustical effects and how we process them will remain at the center of my own future investigations.

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Richard Glover is a Research Fellow at the University of Huddersfield, U.K. His music is performed internationally and is being recorded by EXAUDI and Quatour Bozzini for separate CD releases. He has chapters in forthcoming publications on the music of Phill Niblock and the Ashgate Research Companion to Minimalism*, and is currently working on a book exploring the temporal experience in minimalist and experimental musics.*

Sound Is Not Enough

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ABSTRACT

The artist describes the use of virtual audio for spatial music composition.

As a high school student, I remember bringing in a sketch for a spatial work for orchestra to my first composition teacher only to have him respond that it wasn't "music." I didn't know much about music at the time and was confused by his statement. I always liked sound and secretly preferred it to music. But I thought that I was wrong because almost all of the avant-garde music that I listened to had pitches and rhythms.

Fast-forward 25 years—I am now completely engaged with sampling and sound effects as my palette. I have finally accepted my artistic predilections. I am looking to expand my work and I don't know how. I want it to be "bigger" but not louder. In 1990, I ran across an advertisement for a product called Roland Sound Space. I received a demo version and thought it was fantastic. One could place, accurately, sounds in physical space using only two speakers. This was what I was looking for. Unfortunately, the "sweet spot" was tiny, and the system cost $20,000. Fortunately, I was referred to engineer/artist Bo Gehring. He had software called Focal Point for the Mac [1]. Focal Point did a similar thing to Sound Space but not as effectively.

Bo explained the software as a kind of "super" EQ (Equalization) process. Each dot was assigned a specific EQ, and as you moved the mouse, the sound appeared to move. It was an illusion, of course, but it worked. I could move the sound up, down and from side to side in any configuration. I set up my speakers 14 ft apart, 8 ft from the listener and angled about 45°. I found that I could make the sounds appear to move toward and away from me. The sounds were so vivid; I could almost see a bird flying over my head. The sound became visual. I removed everything in front of me—books, pictures—to better "see" the sound. I could not, however, place a bird sound at a low spatial location. The engineers I talked to explained that we humans expect high sounds to be just that. I also couldn't place any sounds behind me. Because of the reflection of the wall behind me, however, sometimes I could get away with it. I found that the perfect space for this work was a super dry room. Any reverberation interfered with the EQ, which in turn made the spatialization less effective. Also, the "sweet spot" was a circle about 3 ft in diameter. And only one person could hear the work at one time.

I created two works using Focal Point, one for speakers (two) and one for headphones. *Buzzingreynold'sdreamland* [2] was the speaker piece, named after a Coney Island amusement park. My normal composition process uses CDs of sound effects as source (musical) material. A sound effect is a pitch and rhythm idea to me. I never process any of the sounds, unlike almost everyone else I know. Why would anyone need to tweak a bird sound? I can't understand that. If I am not artistically pleased with a sound (musical idea), I find a new one that works. It enlarges my sound vocabulary and produces nice surprises.

The spatialization of the music became an important compositional element. First, I would choose the