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Sound Spheres: A Model of Psychoacoustic Space in Cinema

ABSTRACT

The importance of localisation of sound in our real world is explored and compared with the use of diegetic sound in film, which has been usefully codified by Michel Chion as onscreen and offscreen. To further develop the theory of filmic psychoacoustic space, the Sound Spheres model offers six levels of sonic experience, beginning from the most inner personal sphere and expanding toward the most outer unknown sphere: I Think, I Am, I Touch, I See, I Know and I Don't Know. Real world experiences and perceptual exercises of these spheres inform us how they can be applied to the creation of filmic stories.

KEYWORDS

localisation
sound spheres
film sound

SOUND LOCATION AS A PERCEPTUAL CONSTRUCT OF OUR WORLD

There exists an abundance of studies on how our hearing mechanism functions to help us locate sound sources. However, little has been written on the purpose and use of auditory localisation as an integral part of our lives. The ability to identify the geography of sound in our real world serves us in various ways:

The New Soundtrack 1.1 (2011): 13–27
DOI: 10.3366/sound.2011.0003
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- **Survival mechanism** (e.g. swatting a mosquito, alert to a burglar entry, vehicle driving cues)
- **Enhancement of sports abilities** (e.g. ball movement, opponent's position, field/court conditions)
- **Social bonding** (e.g. finding a lost child in a crowd, following a tour guide, locating a ringing cell phone)
- **Emotional well-being** (e.g. quickly finding the buzzing alarm clock, cat scratching the door to be let in, footsteps of lover arriving)

We react to not only the content of the sound, but also where it exists in our physical space. If it is coming toward us, it can have a very different meaning than if it is going away. If we can see it, it may have a very different impact than if we cannot see it. These conditions are inherent in our perceptual construct of the physical world and offer parameters for the use of sound in cinema.

ESTABLISHED MODELS OF PSYCHOACOUSTIC SPACE AND AUDITORY COGNITION

Michel Chion (Chion 1994) has established a valuable lexicon for localising sound in film. These terms relate both to the screenplay and the film itself, serving to establish the basic sonic geography and who may or may not (characters, audience) be hearing these sounds.

Onscreen sounds have their source visible on the screen and pertain to the internal story world (diegesis).

Offscreen or **acousmatic** sounds are those sounds that pertain to the internal story world, but whose source is not seen by the audience.

Off story or **nondiegetic** sounds are all sounds outside the experience of the characters in the film's story world (e.g. music score, narration).

Another approach that is commonly used, and overlaps with Chion's model, is that of establishing the perspective or point of view (p.o.v.) of any given sound. There are many combinations of p.o.v within the two basic areas of 1st person and 3rd person.

1st person p.o.v. refers to those sounds heard by the character onscreen. This p.o.v. may be the same as the other characters, or not, and may be the same as the audience, or not. For example, a memory of a sound that is experienced by a character will most likely be heard only by that person, not by other characters, but will be heard by the audience as well.

3rd person p.o.v. refers to the sounds heard by someone besides the character(s) onscreen, usually any nondiegetic sound. But there may also be an onscreen sound that is revealed to the audience (like a bomb ticking), which is not heard by the film character. Or it may be the opposite, when a character may hear a phone voice that the audience does not hear, reverting to 1st person p.o.v. only.

In **Auditory Scene Analysis (ASA),** which pertains to the field of cognitive psychology (see Bregman (1994), Farnell (2008) and McAdams

(1993)), relevant consideration is made for level of awareness of a sound in order of 'strength'.

Discrimination: You can hear a sound as separate and different from other sounds, but you can't necessarily say why, or talk about its features.
Classification: You can say the sound belongs to a certain kind, type or class.
Recognition: The sound is one, or very like one, you've heard before.
Matching: You can be certain the sound is only one from a group of several other known, competing possibilities.
Identification: You're sure the sound comes from a specific thing or person.
Correspondence: In the presence of a visible object, you know it is precisely 'that' thing and can point to it.

ASA distinctions have great potential for integrating with the Sound Spheres model presented here, particularly in further comparison and contrast with the I Know and I Don't Know spheres.

In this article, reference is also made to Chion's terms of **listening modes**, defined as follows:

Causal: listening in order to gather information about its cause or source, whether specific or of a category
Semantic: listening that refers to a code or a language to interpret a message, whether spoken verbally or produced by non-human sources
Reduced: listening that focuses on the traits of the sound itself, independent of its cause and its meaning.

GENESIS OF SOUND SPHERES

As a sound designer, musician and filmmaker, much of my creative work is based on personal experience in the world, based on my own senses. I have spent a great deal of time alone in the wilderness listening to unknown animal calls and finely sculpted natural soundscapes, as well as in foreign countries that offer unexpected sonic reflections of human culture. Through the simple act of listening and observing my own physical, mental and emotional reactions to the surrounding sounds, the stories of these places, people, creatures and events began to coalesce into a pattern. This pattern was drawn from the previous theoretical structures I had learned from studying and creating films (traditional models mentioned above), but extended beyond into this dynamic model that I now call Sound Spheres.

Several revelations occurred, as I noted a sonic experience that felt like it could be translated into the filmmaking world of sound design. The experience of, 'Did I hear that, or was that my imagination?' gave me the tingle of excitement that happens in a good film with subtle cues, like a detective novel. Sometimes that inner sound would compel me into action as much as any externally heard event. I began to consider that my own

mind generating the thought of sound could be as significant as the external sounds, and this became the innermost Sound Sphere in the developing model, the I Think sphere.

Another significant psychological impact was discovered when I or someone else would be startled or humored by a sound, saying, 'What was that?' It obviously was 'offscreen' and out of our sight, but even more important to note was that it was out of our minds to be able to identify the source, creating a specific emotional reaction. In Chion's terms, I could identify with reduced listening (volume, pitch, timbre, etc.) and often with semantic listening that evoked some emotional feeling, but I would be clueless to the causal listening because I didn't know the source. Most often this wouldn't last long, being revealed when I'd turn my head or someone told me what was going on, but sometimes that strangeness would linger in the dark unknown, building tension and even motivating a physical reaction to go find out or run away from the sound. This became the outermost Sound Sphere, the I Don't Know realm, out of balance, full of intrigue and ripe for discovering something new.

Being in meditation, simply listening to the sounds and identifying their whereabouts and my feelings (if any), was a fairly passive experience. It didn't capture my genuine interest to stay with the experience, until I began to note the *movement* of sounds between the spheres. For example, when I couldn't figure out what the source of a sound was, that caused me anxiety. Upon seeing where it came from (entering the I See sphere) I would be able to relax or go into action depending on my reaction to the true nature of the sound source. Another movement between spheres occurred when I caused a sound by touching an object like a sweater (I Touch sphere), but the sound was unusually crisp, giving me a surprise. When I looked (I See sphere), I had touched a potato chip sitting on top of the sweater. Not extremely dramatic, but it did reinforce the notion of movement between the Sound Spheres as a clue to sonic storytelling.

The continued experiences that I had, plus the experimentation in this area for several years with my sound design students, resulted in a formalisation of the Sound Spheres model presented here (see Figure 1).

SOUND SPHERES MODEL

If we consider the human experience of our environment from its most intimate to most external, a model of six concentric spheres serves to describe the various levels of sonic information available. Like the layers of an onion, an outer sphere may encompass some of the properties of inner spheres, but not as an absolute rule. As a perceptual construct of our world, this is a model to be explored, debated and expanded upon in relation to other audiovisual theories, as well as psychoacoustic and philosophical approaches.

The descriptions below pertain to real life experiences. Applications in the audiovisual world will be discussed in a later section.

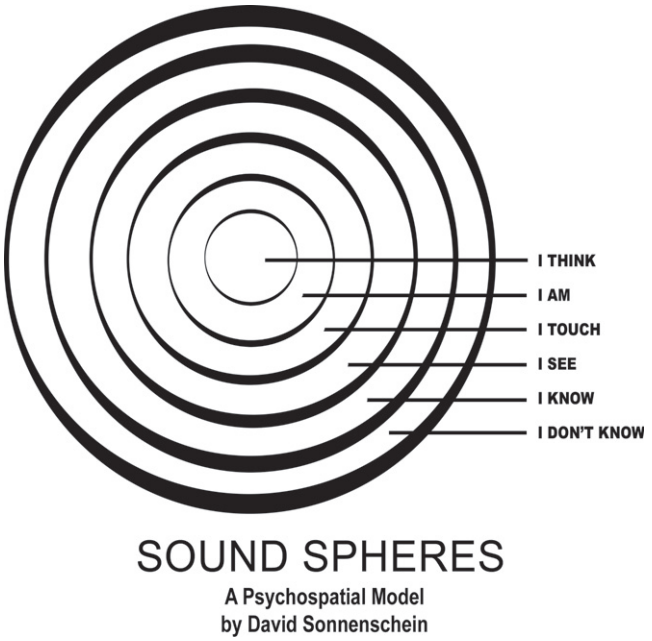

Figure 1 Sound Spheres model.

Think

When we perceive a sound, but no one else can hear it, it is likely to be an internal sound that is generated by one's own mind. There may be a doubt of its physicality if it is an extremely soft sound or pitched very high or low, perhaps one that is beyond the hearing range of most normally endowed listeners. But for the most part, this sphere represents personal audio thoughts that are simply not available to other listeners, unless we are told about them.

Examples: *memories, daydreams, dreams, mental rehearsal or notes to oneself, internal music.*

I Am

Our bodies are organic factories full of vibration, friction and impacts that create sound. Many of these can only be heard by ourselves, if we even notice, as normally we are habituated to constant low level rhythms of breathing, heartbeat and even neurologically based auditory stimuli like tinnitus. However, slightly louder bodily functions become audible to us and to those around us, sometimes with unintended, embarrassing results. Speaking and clapping are more obvious sounds we make for the purpose of communicating with others. This sphere represents the interface between the very personal, private and personalised arena of sound making and that of interaction with others.

Examples: *heartbeat, breathing, digestive sounds, flatulence, mouth sounds (chewing, coughing, hiccup, sneezing, crying, etc.), scratching, clapping, speaking.*

I Touch

When we make contact with the outside world, manifesting our willpower through our bodily movements, this action sets up sonic vibrations. Often it is initiated by our hands, the major anatomical marvel that distinguishes us from most other animals. We have the capacity to smash materials with heavy objects, delicately finger minute particles and complex musical instruments, and communicate through sophisticated symbols on electric devices. Our whole body plays the environment like a drum set, slamming doors, pounding up stairs, sweeping the floor and turning the pages of a newspaper.
Examples: *footsteps, manipulating tools, utensils, food, contact sports, typing.*

I See

The experience of this sphere is equivalent to the filmic notion of 'onscreen' audio, where events, objects and actions in our field of vision are perceived as the source of the sound we are hearing. Psychologically, this sphere usually represents a distancing of our ability to affect the world, as the act of listening becomes more passive than I Touch or I Am. However, this might also include the previous spheres of I Touch and I Am, if we are watching our own body creating a sound (like seeing our hands play the piano, or scratching our arm), or may not (like playing the clarinet with our fingers below our field of vision, or scratching our back).
Examples: *mouths moving with speech, television, cars passing by, boiling teapot, bat hitting baseball.*

I Know

This and the following sphere (I Don't Know) relate to the sense of offscreen sounds, where the source is not visible to the listener. The context of the environment and types of sounds expected to occur in that environment create a sense of familiarity with the soundscape. When a banging noise happens out of sight in the kitchen area, it is easy to guess that someone is washing the dishes. But the same sound coming from the bedroom generates a big question mark in the listener. It is often easy to identify the person on the other side of a phone call without their name being introduced, because of the personal recognition of the voice. But if the voice is not familiar enough, we have to ask, 'Who is speaking?' and this falls outside of the I Know sphere into I Don't Know. The sound of a coyote howling in the hills of Southern California is very identifiable, but the same sound in the city mall would be strange and misplaced.
Examples: *people talking outside our vision, radio music, crickets, birds, wind.*

I Don't Know

Although not so common an experience as the other sound spheres, the I Don't Know sphere can be a very memorable and potent one. When a sound cannot be identified, for however long, we normally are compelled to find out what is the source. Perhaps if it seems innocuous, weak or doesn't repeat itself, we may not give much attention and ignore it. But if

there is any power to the sound in either reduced listening (e.g. loud, sharp attack, repeated) or semantic listening (e.g. scary, funny, oddly familiar), then our conscious minds can barely resist being drawn into the quest of source with causal listening. It serves as a catalyst for problem solving, shifting complacent energy into action. The speed of moving from unknown to known may also be influenced by culture, education and exposure to similar kinds of sounds. For example, research (Murray *et al*) has shown we can recognise man-made sounds faster than natural sounds. Auditory Scene Analysis can offer a systematic gradation between I Know and I Don't Know.
Examples: *Because these are all unrecognisable sounds that are out of sight, no source examples (causal listening) can be cited without exiting the I Don't Know sphere and being thrown back into the I Know sphere. However, acoustic parameters (loud-soft, high-low pitch, short-long, etc.) and emotional qualities (soothing, inappropriate, frightening, etc.) can be described.*

EXAMPLES OF SOUND SPHERES MODEL

During the last several years I have introduced the Sound Spheres model to my sound design students and given them the following assignment:

> Sit for 3 minutes and write down every sound you hear, associating each with a specific sound sphere. You'll probably list between ten and twenty sounds and their respective sound sphere placement. What informs you of your environment, what draws your attention, what creates a feeling or emotion? Note in particular which sound shifts from one sphere to another. Where do you experience transitions, tension, build, climax and resolution? How can this be used in a filmic scene to move story?

The purpose of the assignment is to have the students experience their own sound spheres, then to apply this in a possible dramatic film scene with an evolving plot. An extra benefit that frequently derives from this exercise is the opportunity to explore related audio theory and applications, which are noted below. Here are some of the results of this assignment.

Example 1 – School orchestra

I play violin in the school orchestra and did this exercise during one of our rehearsals.

I Think – This seemed to happen when I imagined the notes I was going to play in the upcoming measures, kind of like rehearsing them. Also, when the conductor stopped us, I could still hear the music like it was reverberating in my head, a very short term memory.

I Am – I couldn't hear my own sounds when the orchestra was playing, but when it stopped, I noticed my own breathing. Then I hummed a part of the melody, so I guess that was also in this sphere.

I Touch – That was really obvious when I played my violin. I'm the one controlling the bow and changing the length of the strings to create the sound. There was also the page turning and my foot tapping the beat (although I'm not supposed to do that for performance, doesn't look good to the audience).

I See – All the other musicians I can see playing their instruments and the conductor talking and tapping his baton on the podium.

I Know – All the other musicians I can't see behind me or hidden behind their music stands, but I know what instruments are being played by their sounds. Somebody behind me whispered something, couldn't tell the words but I know who they are.

I Don't Know – Our practice room is pretty well insulated, but I could hear a low thump outside, very muffled, couldn't tell what it was. It didn't seem like a problem, nobody else paid attention.

NOTE: This experience highlighted the overlap between music, sound effects and dialogue in our everyday experience. Although these areas of audio are frequently separated in the production and post-production processes of filmmaking, the application of the Sound Spheres model applies equally to all types of sounds.

Example 2 – Police station

I'm a part-time student and have a job as an administrator in a police station.

I Think – I'm still listening to the song in my head that was playing on the radio when I was driving to work.

I Am – I've still got a little tickle in my throat from a cold and have to cough a couple times, take a drink of water. I talk to a guard who needs some information about a prisoner.

I Touch – I'm typing on the computer, making some notes with a pen on paper. When I lean back, my chair squeaks. I set a cup of water on the desk.

I See – The guard talks to me. The phone rings.

I Know – I hear the footsteps of the guards and several doors and bolts, knowing where they are even though I don't see them. I can hear what seems like an air conditioning hum. More unusual is the sound of a cricket inside the station, which I look for but can't locate.

I Don't Know – I don't hear any sound I can't recognise.

NOTE: The cricket sound generated a lively discussion about the nature of having a living being inside a high security building that can't be located. Furthermore, the cricket most likely has the ability to come and go with little restrictions, a very unique skill in contrast to all the people there in their fixed roles and pre-determined locations. We considered that this cricket sound could become a sonic story element, representing a 'ghost in the machine', rebellious, free, unbound by the rules of that place.

Example 3 – Apartment

In my room resting, waiting from my cousins to come visit.

I Think – Not aware of anything inside my head.

I Am – I hear my breathing.

I Touch – My pen makes a noise on the paper. My footsteps.

I See – The cat scratches the sofa. After getting up, I see the neighbour kids.

I Know – There are some kids' voices outside. At first I think it might be my cousins arriving who I am expecting, but then I get up and see that it's the neighbours having a party.

I Don't Know – I don't hear any sound I can't recognise.

NOTE: In this case, the I Know sphere was correctly identifying kids' sounds, but incorrectly assuming one specific source (cousins). The movement from I Know to I See sphere revealed the mistaken assumption and the correct source (neighbours). This example illustrates a powerful audio storytelling technique, leading the audience toward an incorrect assumption through a built-in expectation (either within the film story itself or from the typical cultural references), and then revealing the true nature of the sound source in the visuals.

Example 4 – Sound studio

I'm in my sound studio taking a break from editing to do this Sound Spheres exercise.

I Think – I'm imagining my upcoming trip, so can hear the sound of the plane I'm taking, the people and dogs I'll be visiting.

I Am – I'm chewing gum. I swallow Red Bull (energy drink) and feel my heart speed up.

I Touch – I touch the pen to the paper.

I See – Computer monitors showing a film scene running, but there is no sound.

I Know – I hear somebody rolling a cart in the hallway, but don't know what's on it. I hear a dog barking outside. This kind of triggers the I Think about my trip.

I Don't Know – Nothing in that sphere, except details of what's on the cart.

NOTE: The imagination of the future can refer to a previous experience or scene in a film, perhaps with a desire to return. It can also trigger or foreshadow the actual event, which may or may not come to pass as imagined. This creates story tension between expectation and outcome. A transition from I Think to I See spheres can be done in the film cut as a pre-lap, collapsing the time frame from future to now.

The observation that the monitors are showing a film scene with no sound brings up the issue of *suspension* of sound where it might usually occur. In the case of this exercise, the I See sphere is referred to where the sound would be expected, but is not happening. It may be conveying simple absence, or perhaps a real defect in the proper functioning, generating the question in the audience, 'Is there something wrong?' The story context should tell us if that is important or not.

Example 5 – Living room

I'm watching TV in my living room and hear a knock on my door, go to open, but there is nobody there.

I Think – After this experience, I wonder if I was just thinking that I heard the knock. It worried me a bit about who was out there, or if I was having a kind of auditory hallucination.

I Am – I'm filing my nails.

I Touch – I walk on the hardwood floor and turn the doorknob.

I See – I see the sounds coming from the TV.

I Know – I hear a knock on the door.

I Don't Know – Now I'm really confused after opening the door, because I don't know if I really heard the knock or not.

NOTE: When asked how she knew the knock didn't come from the TV, the student said that it came from a different direction and that it had a

much fuller frequency range than would come from the TV speaker. So this exercise helped illustrate the psychoacoustic Gestalt principles of grouping by proximity and similarity. All the TV sounds grouped together (*fusion*) with similar directionality and timbre, while the door knock separated from this group (*fission*) with dissimilar directionality and timbre.

The movement of the door knock between Sound Spheres (I Know, to I Don't Know, to I Think) could be a classic example of the tension built up in a horror or suspense film, setting up an ambiguous reality which questions what is really happening. Is it an external malevolent force, a mind playing tricks on itself, or something we can't imagine (yet) as the story unfolds with unexpected plot and character developments?

APPLICATIONS OF THE SOUND SPHERES MODEL IN FILM

When transferring the theory and experiences of the Sound Spheres in real life to audiovisual media, and focusing on the diegetic aspects of sound, the following considerations come to light with some film examples.

I Think

The 1st person p.o.v. in film sound gives us the subjective experience of the character. When this experience transcends the external environmental sounds (all the other Sound Spheres), we enter the I Think sphere of the internal sensory, mental and emotional world of the character. This can include memories, dreams, fantasies, daydreams, hallucinations, imagined fears and desires, and projections of the future. The kinds of sounds are limitless and totally subjective. To distinguish this sphere from others, significant sound processing will often be added, e.g. EQ, reverb, delay, speed and pitch shifts, panning/directionality, reverse. An example of I Think sphere is the opening sequence of *Apocalypse Now* (Copolla 1979), where Capt. Willard's own voice is heard with no lip movement as if it is his thought, having been recorded in almost a whisper at extreme close range (timbre/EQ), and played back in surround speakers (wide directionality). (In contrast, the next scene was recorded with a normal perspective and placed in the center speaker only, putting the character into the 1st person I Am speaking sphere, and the audience into a 3rd person I See what is being spoken.)

I Am

Any dialogue could be considered technically in the I Am sphere, since the character is in fact creating a sound with his vocal chords and would say, 'I am speaking.' When a character is in a close up shot, we often want to accompany that with close up character sounds to draw the audience toward the subjective experience. These commonly include breathing and heartbeat. Dialogue tracks are usually 'cleaned up' by removing extraneous mouth sounds, clicks, sniffs, gulps, etc., but these non-verbal utterances may be desirable when experiencing the I Am sphere of the character. We may even add sounds like sighs, chuckles or groans to develop more

character reaction and depth than the dialogue alone is transmitting. In a rather extreme example, Bill Murray's character in *Osmosis Jones* (Farrelly and Farrelly 2001) is infected with all sorts of germs that make his gastrointestinal system a veritable factory of organic sounds. These I Am sounds link directly to the animated action of the bugs inside him and the reactions of people outside him.

I Touch

Production sounds such as footsteps and furniture movement in the I Touch sphere are minimised during locations recording to keep the dialogue tracks as clean as possible. But these sounds are important to lend a greater sense of reality to a scene, so Foley sounds are added in postproduction, representing all the I Touch sounds resulting from the characters' actions onscreen. These include footsteps, clothing rustle, silverware, and anything that the characters touch to make sounds. Sometimes these sounds are exaggerated for a psychological impact, as in *All That Jazz* (Fosse 1979), when choreographer Joe Gideon undergoes the symptoms of a heart attack. The scene becomes extremely subjective, focusing only on his hand movement with a cigarette and pencil, while other sounds of people talking (I See sphere) drop out entirely.

I See

Everything that is onscreen sound can be considered in the I See sphere. The proverbial 'see dog, hear dog' fits this description perfectly. When a character speaks and the dialogue track is in synch, we see the source of the words coming from his mouth. Any hard effect such as a door closing or car passing by onscreen is in this sphere. Although the most common and important function of this sphere in film is to create realistic actions and environments with sound, there are moments that play with this reality for the sake of drama, fear or humor. One example in *Mr. Hulot's Holiday* (Tati 1953) shows Jacques Tati walking merrily to the synchronised sounds of ping-pong balls. Our minds glue the steps to the bouncing ball sounds, so they are associated in the I See sphere as a single unit, until the moment that Tati passes by a ping-pong table showing the actual source of the sound. Our I See sphere is immediately adjusted, and we experience an emotional burst as our brains recognise having been duped, then corrected.

I Know

Most offscreen, diegetic sounds would fit into the I Know sphere (except those in I Think or I Don't Know spheres). This includes any offscreen dialogue from characters who have been introduced previously, such as an over-the-shoulder shot of a someone speaking with his back to the camera. However, if the person is an unknown character, this may fall into the I Don't Know sphere; we know it is a human voice, but we don't know exactly who it is. Most ambient tracks will have sounds that represent something not seen, but familiar enough to represent a specifically known environment (birds, traffic, crickets, wind, etc.). This would be a reference

to something external to the film. Once a sound has been established as being linked to an object or action, then the repetition of that sound later in the film can be identified even without the direct association of an image. This would be a reference to something internal within the film. In *The Usual Suspects* (Singer 1995) we learn early on that Kevin Spacey's character walks with a limp, so that later in the film when we hear the syncopated shuffling with no associated image, it enters the I Know sphere.

I Don't Know

One of the cornerstones for the horror genre is the element of fear of the unknown. In the soundtrack this manifests in the I Don't Know sphere. The audience anticipates this, so there is an implicit pact between the filmmakers and audience in which some sounds that may seem ominous will be revealed in the I See sphere as being innocuous (the iconic strange sound in a dark alley, shown to be a stray cat). The setup gives false security, as one of the later strange sounds will indeed be horrifically realised. Comedy can also utilise the I Don't Know sphere effectively, with a resulting laugh when the strange sound is revealed as a funny surprise. A sound can be a total mystery, never revealed, like the strange tone associated with the black obelisk in *2001: A Space Odyssey* (Kubrick 1968).

Further considerations and possibilities of applying the Sound Spheres model are listed below to show how sound can serve to intentionally manipulate the audience/listener in their physical and psychological orientation.

- Moving from the inner to outer sound spheres will direct the attention of the audience from more personal contact with the character toward more awareness of the surrounding environment. This movement tends to transition from 1st person p.o.v. to 3rd person p.o.v.
- Contracting or expanding the number of spheres simultaneously will limit or expand the attention demanded from the audience. Limiting can help focus attention or create tedium. Expanding can help stimulate awareness or create an overwhelming sensation. A similar effect occurs in both the nervous system and dramatic structure with habituation (relaxation or boredom) vs. contrast (stimulation or overwhelm).
- Transitioning a single sound from one sphere to another can help drive the drama. The storytelling power of sound design is fertile ground for creating tension, anticipation, release and surprise. Some possible movements between spheres: I Don't Know → I See; I Think → I Know; I Touch → I Don't Know.
- The I don't know sphere can transform into any of the other spheres with a visual or psychological 'nudge'. Like a molecule in a highly volatile state becoming transformed by a chemical or thermal catalyst into a more stable molecule, the addition of any relevant and

catalytic information (image or sound) to the I Don't Know experience will inevitably shift the audience's anxious search for meaning into a stable, more recognisable sphere.

- In a story with two strongly linked characters like lovers, twins or mother-infant, the bond may be emphasised by sharing awareness of sound spheres, in contrast to other characters who may not share the same acoustic information.
- If a specific sphere is selectively eliminated, this absence or suspension of normally expected sounds can create a partial void of experience and specific psychological disconnection. For example, if one character (and scenes where they appear) is represented acoustically in all the spheres except the I See sphere, and all other characters (and their scenes) include the I See sphere, then this might create a sense of dissociation between that character and his/her environment. Another example would be the selective elimination of the I Think sphere (after it has been previously presented with certain characters and scenes), so that the audience has no further access to the inner thoughts of a character, a kind of deprivation from the expected; this could be reversed as well, with a growing intimacy as the I Think sphere becomes activated or re-activated.

CONCLUSION

The Sound Spheres model can generate a rich didactic experience in the classroom, ripe for use as an analytic tool in any audiovisual genre. While building upon existing film theory, it stimulates filmmakers, students and critics to sharpen their listening abilities, and catalyses discussion around a myriad of related film sound topics. This model facilitates film sound design and the development of screenplays, storyboards and picture editing, by incorporating the psychological and spatial significance of sound in story and real life. New applications of this theory are encouraged, as well as expansion of the model itself, in further comparison and contrast with established models of psychoacoustic space and auditory cognition.

SOURCES

Blauert, J. (1996), *Spatial Hearing: The Psychophysics of Human Sound Localization*, Cambridge, Mass: MIT Press.

Bregman, Albert S. (1994), *Auditory Scene Analysis: The Perceptual Organization of Sound*, Cambridge, Mass: MIT Press.

Chion, Michel (1994), *Audio-Vision: Sound On Screen*, New York: Columbia University Press.

Copolla, Francis Ford (1979), *Apocalypse Now*, USA: Zoetrope Studios.

Farnell, Andy (2008), *Designing Sound*, London: Applied Scientific Press.

Farrelly, Bobby and Farrelly, Peter (2001), *Osmosis Jones*, USA: Warner Bros.

Fosse, Bob (1979), *All That Jazz*, USA: Columbia Pictures.

Jourdain, Robert (1997), *Music, the Brain and Ecstasy*, New York: Avon Books.
Kubrick, Stanley (1968), *2001: A Space Odyssey*, UK/USA: MGM.
McAdams, Stephen, Emmanuel Bigand (Editors) (1993), *Thinking in Sound: The Cognitive Psychology of Human Audition*, Oxford: Oxford University Press.
Moore, Brian C. J. (1997), *An Introduction to the Psychology of Hearing*, Cambridge, Mass: MIT Press.
Murray, Micah M., Christian Camen, Sara L. Gonzalez Andino, Pierre Bovet, and Stephanie Clarke (2006), 'Rapid Brain Discrimination of Sounds of Objects', *The Journal of Neuroscience*, 26(4), pp. 1293–1302.
Singer, Bryan (1995), *The Usual Suspects*, UK: Polygram.
Sonnenschein, David (2001), *Sound Design: The Expressive Power of Music, Voice and Sound Effects in Cinema*, Studio City, Calif.: Michael Wiese Productions.
Tati, Jacques (1953), *Monsieur Hulot's Holiday*, France: Discina Film.

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