What Are You Hearing? and Why is it Important?

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All living beings possess sensory systems that connect the organism to the world in which it exists. Broadly defined, a "sense" is a system of specialized cells that responds to specific targeted physical stimuli. This connection between an organism's sensory system and physical stimuli forms the basic and minimal requirement for any organism to survive. When something interrupts this connection between an organism and its stimulating environment – when the senses upon which the organism depends are limited in their functioning – the organism's quality of life, even possibly its basic survival, is challenged.

Western culture traditionally names five senses for human beings – sight/vision, hearing/audition, taste/gustation, smell/olfaction, and touch/somatosensation. According to how a given culture defines "sense", as many as 7, 9, 21 or even 360 different senses can be attributed to humans.[1] No matter how sensory data is organized, the significance of this data for human functioning is undeniable. Sensory data from our environments enable us to know these environments. Sensory information enables us to form a cognitive model of where we are, who and what we are, and what sorts of interactions will be successful. To live at all, we need our senses to function. To flourish and thrive, we need our senses to provide us with a constant stream of high-quality sensory knowledge about the world in which we live.

While physical stimuli from external and internal environments are crucial, psychological, social and cultural information transmitted by our internal and external sensory systems is equally significant. Physical stimuli provide "existence" information, and non-physical information allows us to formulate "meaning". Once our sensory systems are stimulated, we need to know what this stimulation means to us for both our immediate and our long-term survival and thriving.

The physical and non-physical (psychological-social-cultural) environments in which we live are the result of decisions. Even when those inhabiting the environments are not those who made the decisions, someone representing the general culture made decisions about what will be part of the environment, and often more importantly what will not. These decisions represent ideas, assumptions and attitudes that have been informed by cultural values. By embodying and

representing these values, environments in turn reify and reinforce the values in a kind of self-validating feedback loop.

Most cultures tend to value one or more senses over the rest. Which senses are advantaged and which disadvantaged differs from culture to culture. The advantaging is systemically expressed in the physical and non-physical environments. For example, in most Western European cultures, the visual sense is valued over other senses, and data from this sense is advantageously expressed in most of the culture's physical and social environments. This favoring and disfavoring is built into the physical environments, and reinforced by the social environments that govern how we live in these physical environments.

Because one or more senses are emphasized and the others are secondary in most settings, users' overall sensory stimulation is limited. Too often, those cultural members who are tasked with designing physical environments produce settings where the uses of one or more of our senses are emphasized, and the other senses are limited in their stimulation. In addition, the non-physical environments that present socio-cultural cues for behaviors in those spaces usually favor these same senses at the expense of the other senses. Together, these physical and non-physical environments create settings in which users' sensory exposure is weighted towards some senses and against other senses, and thus users are handicapped in their overall ability to function and thrive.

We must ensure that our physical and social environments provide the information needed to support our physical, emotional, cognitive, and social well-being and growth. For this to happen, we must acknowledge the significance of information provided by all our senses. We must realize the degree to which our physical environments, cultural values, and social rules determine how well individuals can utilize their senses as they attempt to function in these settings.[2]

Certain activities and conceptualizations are needed to ensure that the entire range of human sensory systems is well supported in our created environments. For example, it is important to produce a sensory audit of a space to support an evaluation of a spatial design; this would ensure that one sense is not favored while the functioning of other senses is mostly ignored. It means changing our cultural values and social, political and economic choices so that we don't create environments that emphasize one or more sensory systems and mostly disregard the rest, but rather that the use of all senses is enabled. This requires political, economic and

cultural efforts that support broad sensory exposure in our physical and technical environments, as well as behavioral choices that enhance the ability of human users to utilize their sensory systems effectively. Similar to the "green" movement that has finally resulted in improved ecological quality of spaces, and increased awareness of the need for behaviors aimed at ecologically sustainable outcomes, we need to support the burgeoning sensory movement that values sustainable sensory-life quality for all users. The Well Building Standard aims to encourage creating environments which do this. Quoting from the Well Building Standard overview:

> WELL is premised on a holistic view of health: human health as not only a state of being free of disease - which is indeed a fundamental component of health - but also of the enjoyment of productive lives from which we derive happiness and satisfaction. Healthy spaces protect us from that which can make us sick, promote practices that can keep us well, and facilitate opportunities for us to connect with one another and live our lives to the fullest.[3]

(Note: The International Well Building Institute, founded in 2014 and based in New York City, provides a globally recognized certification system – WELL – for built spaces adhering to 10 core concepts. These core requirements define and support physical and mental health among a building's users.)

In order to guide our efforts in developing spaces and regulations that support the use of all our senses, it is crucial that we understand the kinds of information about the physical, social and cultural environment that each sense provides. The design and structure of our physical and non-physical settings, our behavioral choices, our culture-wide resource allocations – all must support this broad sensory activity. In addition, for those making art, the sensory experience is the gateway to the world of the mind. When artists know more about what types of information a sense presents to the mind, the artistic palette of expression for potential mental stimulation expands enormously.

A sensory-wide presentation is beyond the scope of this article, however, a close look at the rich variety of data accessed by a single sense – hearing/audition – should be sufficiently convincing to make a strong case.

Sonic Stimuli Provide Significant Information

One of the most important sensory contributors to the way we understand the world we inhabit is through audition. The hearing sense is deeply wired into mammalian brains and is processed faster than stimuli from other sensory systems.[4] It is "on" 24/7, even before birth. We hear across distances, around corners, 360 degrees in all planes, and when vision is useless.

Sound connects us to events in our space, informing us about what is happening around us. Sound communicates the movement of objects and events relative to us, and the movement of ourselves relative to them. Sound enables us to know a space, informing us about the physical properties of objects and spatial environments: their shape, mass, and makeup. We can "read" our surroundings using our hearing.[5] Sound supports our ability to navigate a space. Sound provides sociocultural cues that indicate where we are and how we should behave. Sound has emotional value, contributing to how we feel. Sound can dominate, define, and claim a space. Perhaps most importantly, sound enables us to communicate with speech. Speech is the basis of human interaction and community building. Speech is what connects us to each other, providing crucial emotional support, the ability to consider and share past and future, to discuss and pass on complex new ideas, to engage in creative problem-solving.[6]

Hearing Connects us to Events

Sound is caused by a vibration in air that propagates in the form of audible mechanical waves of pressure and displacement. Actions in space dissipate energy, producing sonic vibrations. While not all sonic vibrations are within the range of human hearing, many important events do produce vibrations within hearing range. Every event has an accompanying sound: the rhythmic *click-clack* of walking on a wooden floor, the *shout*ing of a child in surprise, the *ring*ing of a doorbell to signal a visitor, the *shatter*ing of glass dropped on a hard surface. When we hear a sound, our brain searches within itself for familiar patterns we can use to provide a template for ascribing meaning to that sound. Using familiar patterns, we can know not only the existence of the event that caused the sound, but many other crucial qualities that communicate the event's physical, temporal, cultural and social meaning and significance to the listener.

Sound conveys an array of information about an event; we call the totality of sonic information – the total acoustic environment – a "soundscape".[7] "Soundscape" is a term originally borrowed

from vision: “landscape”, which denotes the visible features of a physical area. Thus, a soundscape denotes the sonic features of physical area. We look at a landscape, and we listen to a soundscape.

However, it is not the physical area itself which is significant for the human being; it is the events taking place in the physical area that are significant. It is the roar of the lion claiming its territory, the thunderous crash of the waterfall, the rustle of the prey moving through the forest that are significant. Sonic stimuli communicate events; they tell us what is happening around us, providing significant information concerning the existence and location of events and their associated array of meanings. This information is crucial for human survival and thriving. Thus it is more accurate to call the totality of sonic information about a physical area a “sonic event-scape”, because the event is what is important for the human being in a given physical area.[8]

The auditory sense is constantly monitoring the background environment for sonic change. Since sound signals event, a change in the auditory background will signal an event. The sonic qualities that capture our attention include change in volume, cessation of sound, change in frequency with particular attention paid to the expression of low frequencies, change in familiar sounds, the sudden onset of sound particularly if the sound is very loud, and the production of inharmonic or culturally determined unpleasant sounds.

When auditory change is detected, the brain stem produces a startle response, an almost instantaneous (less than 10 milliseconds) triggering of arousal, urging the hearer to pay attention to that stimulus! The fight/flight/freeze stress-hormones flood the organism, and a response ensues that enables a successful defense, if needed. The brain then gathers and processes additional sonic data to determine whether the sonic source or the sonic change is familiar, is dangerous, can be responded to at that point, or whether additional data from other sensory sources are needed. At a slightly slower pace, and relying on several brain substrates, the mind uses the working memory to engage past experiences, learning, matching against familiar patterns and models, and context to gain a fuller picture of the event-environment and evaluate it. Based on these cognitive processing activities, the mind is able to use sonic sensory data to reason, make decisions, and determine a useful and appropriate response to the original sonic trigger.[9]

Our auditory sense communicates the source of the sound, the nature of the sound, its location, its meaning, its value, and the modifying physical properties of the physical envelope within

which the sound is propagated. Successfully engaging in these complicated computations, our brain then connects the sound to the event which caused it. Sound connects us to events in our space, and tells us how to respond.

Consider a barking dog in a suburban housing community at night. Our hearing sense picks up the sound because it is sudden in onset, a change from the quiet streetscape. It also captures our attention because it is loud, is a low frequency, and is culturally and personally identified as potentially dangerous. We are startled and frightened. Do we fight, flee or freeze? Additional data about the sound is then processed: the direction from which the sound came, its distance from us, the size of the dog, and whether it is in a nearby house or on the street. Additional data comes to us from prior experiences: Oh yes, there is a large dog on this street that barks when people walk by. That dog is always in a house or in a fenced-in yard – the quality of the sound indicates the dog is outdoors. That dog is guarding its territory and is not interested in being aggressive unless we come too close. We make an evaluation: not dangerous. We make a decision: safe to continue walking down the sidewalk, but perhaps to avoid aggravating the dog, best to cross the street. Through sound, we have been connected via our aural sense to an event taking place in our physical, cultural, and personal-psychological environment. We have experienced a sonic event-space.

Binaural Hearing Helps us to Localize Events

Sound tells the eyes where to look. Because human ears are placed on both sides of the head, sound reaches each ear at a different time and at different amplitudes. The brain computes the differences and produces a determination of direction from which the sound originated. A footstep, a lion's roar, a clap of thunder, a rush of water – binaural hearing adds to the awareness of an event by allowing us to localize the event relative to the self. A determination can be made assessing the implications for further engagement with that event.

Sound contributes to determining distance and movement of a sound source. Qualities of sound that contribute to our ability to perceive the distance of an event from the self include sonic dispersion, reverberation, and changes in the spectral balance due to air absorption.[10] The Doppler Effect – the change in pitch of a sonic event as the sound-source and the observer move toward or away from each other – communicates movement of an event relative to the

self. A human listener can determine whether the event source (car, train, plane, or lion) is moving toward them or away by the upward or downward shift in pitch.

Rising sound intensity also communicates movement and distance relative to the self. There are brain substrates that are particularly sensitive to rising sound intensity, which serves as an early warning system of approaching danger.[11] Whether it is the increasingly loud sound of a stampeding elephant herd or an approaching train, this provides adaptive advantage in decoding the external world.

The ascription of such meanings to complex sonic stimuli by cognitive processing complements information being supplied by vision; the senses work together to create a fuller picture of the environment, facilitating the listener's ability to place themselves within their space. When sound comes to the listener from all directions at once at a consistent decibel level, the ability to achieve sonic location becomes much more challenging: the listener might experience a sensation of floating, untethered within space. While artistically this can be a curious, pleasant, even exhilarating experience, it can also be unpleasantly disorienting if the listener is attempting to navigate through or function within the space.

We Can Read a Space Using Reverberation Cues

When sound waves pass through air in an enclosed space, they reflect off the surfaces of the enclosed space. These surfaces include not only the six surfaces of a typical enclosure, but also the surfaces of whatever is in that enclosure, including objects and people. In a non-enclosed space, these waves do not encounter reflecting enclosures, but they do reflect off the physical elements in the space, including trees, people, hills, water, and so on. Each type and shape of reflective surface absorbs, reflects, and diffuses sound waves in different ways. The human ear hears and the human mind decodes the differences, "reading" whether the space we inhabit is open or enclosed; the volume of the enclosure; the materials of the enclosure; the number, materials, and shapes of the contents; and the placement and direction of objects and reflective surfaces in the space. We are constantly reading a space with our ears, whether consciously or unconsciously.

An excellent example of the ability to read a space through acoustic cues has been presented by Daniel Kish, a blind individual who has become expert in human echolocation. By producing

a continuous set of vibrations from a sound source such as a click, Kish has taught blind individuals to hear and decode the sounds reflected back from objects in their environment. With training, these individuals can produce a sonic-image in their minds. Kish suggests that this is achieved by using the part of the mind that, in a sighted person, would be used to form a visually based image. Kish and his students are able to sonically "see," and successfully ride a bicycle on a path through a forest.[12] Kish and his cohorts are using sonic data to create their realities, substituting sounds for visual data.

All hearing individuals use reverberation to "read" the space they inhabit. Combining what we hear with what we see, often without focused attention being paid, we use the information of our senses to navigate our surroundings and avoid bumping into walls, people, and furniture. We aurally know when a wall is nearby, when we are passing an open window or door, when we have crossed from a carpeted to an uncarpeted floor, when we have transited from a small enclosed space to a large enclosed space, when we are walking down the sidewalk of a busy street versus an empty hallway, and so on. The spaces speak to us.

Auditory information combined with information provided by other senses creates a functional "image" of the space, helping us to navigate our physical world successfully. Research has shown that people who have a mild – 25 dB – hearing loss have almost three times the likelihood of falling; every 10 dB of hearing loss increases the likelihood 1.4 times. The reasons are speculative, but one reason put forward is that hearing contributes important information about the environment. If those with hearing loss cannot successfully compensate for the loss of this information by accessing data from the other senses, they have difficulty navigating challenging spaces.[13] We do not have to be aware that we are receiving information from our senses in order to derive a benefit.

Sonic Event-Scapes Communicate Locational and Behavioral Cues

The ways in which space is organized and used embody and encode the values, customs, and conventions of a society or culture. Behavioral norms, including those norms relating to sonic behaviors, result in public order by producing an organized, predictable, and thus safe social environment, and enhancing identification with the group. We learn when and where various sonic behaviors are appropriate, and when and where they are not. A sonic behavior might be

acceptable in a location at one time, but not at another time. For example, cultural members know when and where it is customary to shout or not, to use rude language or not, to whistle, hand clap, make music, stomp feet, laugh loudly, or not, and so forth. Depending on the context, the same sonic behavior might or might not be welcomed, and the person(s) emitting such sounds might or might not be welcomed. Physical space, therefore, is also cultural space, and auditory behavior is a sonic representation of a culture's expectations and norms; sonic behavior is culture made material. If we do not match our sounds to our spaces, we risk being socially and culturally discordant and disconnected.

As cultural members, we are taught by acculturation to match our sonic behavior to the expectations inherent in a particular cultural event-scape. We know that if we are at a sports game and disagree with the umpire's call of a play against our team, we are encouraged to "boo" loudly. Doing so shows our support of the team and our membership in the collective fandom. On the other hand, if we are at a symphony concert and we disagree with the way the conductor is interpreting the musical score, our only sonic recourse is to applaud tepidly if at all. If we break the sonic behavior rules, we risk being identified either as a cultural outsider or as a cultural rebel by deliberately flouting sonic spatial-use rules.[14]

We Move Through a Variety of Cultural/Sonic Spaces Throughout Our Day

An event-scape is the totality of sounds in a particular place at a particular time, including the way environmental acoustics changes those sounds as they travel from the sound-source to the listener. Because specific spaces encode specific sonic behaviors, both spaces and behaviors become associated with signature sets of sounds. As we move through a variety of spaces, we encounter a variety of recognizable auditory environments. We know, simply by what we are hearing, whether we are at a baseball game or in an office; whether we are on a busy urban street corner or in a home kitchen.

As we move through our day, we transit through a variety of sonic environments. We recognize these environments, and we match our culturally mediated sonic behaviors to them. In the morning, we usually begin our day in a quiet, private space. If we are part of a family, we hear the sounds that accompany the family's preparing for the day, and we contribute to those sounds with our own preparations. As we enter those places associated with commuting to

work, we hear the sounds that are part of the technology of moving large numbers of people through urban spaces. We might choose to block out these sounds by introducing an alternative, private sonic environment via earphones through which we play sounds of our own choice, or by traveling in an acoustically tight capsule such as a car. When we arrive at our place of work, we participate in appropriate sonic behavior as we make our way through our day in the work world. We know when and where to talk and conversely to keep quiet – we always use our "indoor" voices. We know to make sure our private conversations are not overheard by others. After work, we enter different worlds: a noisy social bar with coworkers; a low-conversation gym with sounds of exercise music thumping and the clanking of workout equipment; a child's raucous sports game with coaches and parents vying to support their children's teams. Each of these places encloses a specific type of activity and specific accompanying sonic behaviors. Each sonic environment is a different cognitive reality.

Each sonic event-scape is unique because it is a combination of the sounds generated by the events that take place in it, modified by the reflective surfaces of that particular space, all occurring at a particular time. The sonic cues of an event-scape often tell us not only where we are but also what time it is, what the season is, and even what time-period it is.

Increasingly, however, our spaces are becoming internationalized – for example, shopping malls, urban streets, airports, large office buildings. These are all beginning to have consistent and predictable sonic event-scapes because the architecture is consistent, the activities in them are similar, and the technology used there is very much the same. If we close our eyes and ignore the language being spoken, we are hard pressed to determine by sound if we are in Tokyo, Berlin, or New York City. Unique sonic event-scapes are disappearing; our daily sonic event-scapes are being homogenized by uniformity. The sounds accompanying our lives are also being homogenized, as are our sonic behaviors. While this enables us to function universally, the pleasure of immersing ourselves in uniquely textured sonic event-scapes is being lost.[15]

Sound Claims Territory

Sound normally radiates in all directions. We use sound to claim the three-dimensional spatial area within which the sound is heard. Alain Corbin describes how, in nineteenth-century France,

the sound of the church bell was used to mark both time and identity. Village bells represented the prestige of the community, its honor, and its reputation. The sound of a village's bell marked the boundaries and extent of the village territory – if a villager could hear the bell, they were a citizen of that village.

The ringing of the bells also marked events and belief systems. Disputes over who could ring the bell and for what kind of event were part of disputes about religious versus secular control of villagers' lives, the relative strength of local versus national control, differences of political loyalties and beliefs, and even controversies with neighboring villages over boundaries and economic issues.

As the casting of bells became less the province of itinerant bell-makers, who invoked mysterious rituals and produced bells locally and with identifiable sounds, and more the product of distant factories producing uniform-sounding bells without using rituals, the significance of the bell-sound diminished.[16] Possibly the final demise of this kind of aural spatial claiming was brought about by the advent of more universal aural communication systems – telephone, radio, movies, and television. Bells no longer had any special, locally identifiable role to play. Villagers became citizens of a global territory.

In traditional cultures, sounds produced by bells, percussive instruments, chanting, and firecrackers are thought to drive away evil spirits, purifying the hearers and the spaces where the sounds can be heard. In Japan at midnight on December thirty-first, Buddhist temple bells are struck 108 times. Buddhists believe there are 108 passions and desires that entrap humans in the cycle of suffering. Hearing the bells will help to free the listener for the coming year. Sounds can also bring blessings. In Myanmar, Buddhist practitioners ring large bells at holy sites, located so the sounds carry across a distance. It is hoped that people hearing the sounds of the sacred bells, inhabiting the delineated sacred space, will experience blessings. In Islam, the *adhan*, the call to pray, is chanted five times per day, emanating from the minaret atop the local mosque. The sound spreads out across the landscape like a sonic dome, creating sacred space within it, stating the basic ideology of Islam for all to hear who are within the sonically delineated area.

Sound Can Elicit and Direct Emotions

The connection between alarming noises and perceived danger, between hearing and emotion, is a very early one in our brain's development. In addition, the processing of sonic stimuli occurs in multiple locations in the brain, often in areas close to where our emotions are being generated and processed. Hearing is thus closely intertwined with experiencing emotions. What we hear, and under what conditions, can contribute to the emotional content of our cognitively created realities.

Sound is fast-acting and appears to be powerful in bringing a variety of emotions to conscious awareness; this appears to hold true across an array of cultures. Both the human voice and music appear to be particularly evocative, as are sounds that are important to human survival and functioning. Generally, familiar sounds are more easily identified and more quickly reacted to. When we hear our name or a familiar voice in a noisy situation, these seem to jump out from the background sounds. When we process the meaning of speech, we first have an intuitive emotional response to the sound itself, to the paralinguistic aspects; then, more slowly, we call on the various parts of the brain to process semantic content in what seems to us to be a rational approach.[17]

The emotions associated with an event and evoked by a sound can be positive – hearing the sound of waves on a beach for a person who spent their early years near water can remind them of early home, of a time of safety and comfort, and of the people associated with that time and that place. The auditory association with a time and/or place can also evoke negative emotions – hearing a car backfiring can remind a war veteran of exploding ordinance and the associated fear of danger and death, of a place and time of war, and of people who were part of a powerful and frightening experience.

The modern, worldwide rise of interest in secular spirituality is often associated with sounds that are thought to evoke inner personal transcendent feelings, creating an inner infinite space. Some of these seemingly-evocative sounds come from the natural expansive world, such as running water, bird sounds, wind moving chimes or rustling leaves. The more these sounds of nature are associated with spiritual experiences, the more evocative their power becomes for those in the secular spirituality movement, and in turn the more often they are used to signal spirituality, openness and transcendence, thus producing a self-reinforcing loop.

Carefully crafted sound directs the emotional attention of the viewer, controlling the type and degree of the viewer's arousal. When the two senses of vision and hearing are associated, they reinforce each other. The image brings the associated sound to the forefront of consciousness, and the sound brings up the associated image. Together, they can evoke affiliated emotions.

Reverberation Can Signal What to Feel

Certain types of reverberation might be associated with certain types of emotions. Some associations are mediated by culture, but others seem universal. For example, an enclosed space that is very large, has a very high ceiling, has hard reflective surfaces and has a central area that is open, such as a cathedral, a mosque, a train station or airport, the entrance to a public performance or meeting space, or a large cave will produce a unique set of sonic reverberations that are instantly recognizable by those whose culture includes such spaces. Our minds attach associations from the activities usually held in such spaces to the associated reverberation, producing emotional responses. Reverberations from religious spaces such as mosques and cathedrals might be associated with spirituality and can produce emotions of reverence; train stations and airports might be associated with travel and can produce emotions of anticipation or anxiety; entrances to large museums or performance spaces might be associated with special events and can produce emotions of excitement and eagerness. Universally, it appears that large caves might be associated with nature's mysteries, potentially producing emotions of wonder and nervousness.

A Big Sound Is Powerful, Dominant, and Dangerous

A low pitch communicates a larger mass – a tuba or an elephant; a high pitch communicates a smaller mass – a piccolo or a parakeet. Evolution favors the life form that can dominate the environment and dominate competitors. Big mass equates to big energy, which equates to power, which equates to dominance, which equates to survival.

Since the auditory system is associated in the brain with those substrates that deal with arousal and fear, we can use sound to shape and control interactions. For example, we raise the decibel level of our voice to intimidate others, often lowering pitch as well. In comparison, we speak in a

low-decibel, high-pitched sing-song voice to babies to signal safety. The word content is less important than the emotional message extracted from the sounds and all that implies to the mind in terms of arousal and fear, or safety and comfort. In understanding language, we first process the meaning of the sound itself, using paralinguistic cues that include volume, pitch, and intonation. Understanding the word content comes later and, if the sound is sufficiently evocative, can be almost irrelevant.

We can use loud sound as combat. Consider two opposing sports team-fans, shouting over each other, making loud sounds with various instruments. The sonic volume contest is an equivalent to the sports-field contest. Military bands have loud instruments: horns of all sizes and timbre, drums of various types. Such instruments contribute to making the sound loud and attention-getting. Listeners' hormones are stirred. They are assured that military might matches sonic might. In the same way, an automobile driven with the windows open and the sound system cranked up to maximum is attention-getting and potentially intimidating to all who hear it; the driver can be experienced as dominating the physical space.[18]

We Are Social Animals Who Rely on Our Ability to Hear Speech

Human emotional well-being depends upon being able to connect and communicate with each other, and speech is a significant way in which this can occur. For example, if older people lose their hearing, they cannot participate in social interactions with ease. This social isolation takes its toll through decreased emotional stability, potentially leading to feelings of loneliness and depression. Research suggests a relationship between hearing loss and onset of all-cause dementia, with the severity of hearing loss associated with a concomitant increased risk in severity of dementia.[19]

Humans have developed spoken languages that provide a tool for thinking and communicating complex ideas, including those about past and future; to form and sustain groups; to nurture emotional stability; and to harness the variety of human abilities found in a group to create powerful meta-instruments.

Vocabulary and grammatical structure are the basics of spoken language, but there is much more that is communicated with non-lexical sounds. These paralinguistic cues depend on variations in the prosodic features of the voice itself, such as volume, speed, pitch and pitch

contour, intonation, cadence, lilt, inflection, tone, stress, and rhythm. In addition, there are non-word specific sounds such as a cough, gasp, sigh, throat clearing, and hesitations. All of these communicate the speaker's state of mind – their emotions, attitudes, and intentions – as well if not better than words are able to do. Paralinguistic cues can also attest to the speaker's class, geographic origins, educational level, and first language. While language is often written and thus becomes visual, language originated as sound; hearing language is one of the essential sonic activities in which we engage.

Language acquisition, comprehension, and production require many cognitive processes, involving several areas of the brain and the pathways among them. The centuries-old debate about whether or not language shapes the way we think, see the world, and behave had been unresolvable because there had been no way to test the hypotheses in either direction. In the last several years, however, neuroscientists have focused on tests that show the degree to which linguistic processes are fundamental in shaping cognition: in determining how we understand the world and how we act in it. The language we speak influences such cognitive activities as memory, learning, category formation and distinction, spatial and temporal concepts, causality, emotion, our way of understanding motivation, and our way of engaging in risk-taking. And, as we learn new languages, our conceptions of the world change to reflect the new concepts embodied in the new language.

The significant contribution of language in forming our cognitive models suggests that what we hear significantly shapes our realities.[20] If we are in an environment where we cannot hear each other's speech, we are shut off from human connection and cultural experience.

Successful Aural Architecture

Typically, those space designers who consider the experience of sound in creating their physical environments focus on noise minimization or elimination. "Noise" is usually defined as sounds above the international legal limits over a period of time, such as the level of sound found in many contemporary public spaces, particularly those associated with entertainment. However, to achieve greater functionality, the definition of "noise" must be expanded. For example, "noise" is also those sounds that are external and extraneous to the targeted activity of a space and transfer or are transmitted in, such as sirens which invade a theater or a school,

or sounds of conversation in a hallway outside a classroom. These transferred or transmitted sounds interfere with the ability to hear those sounds that are preferred in a particular space and time, and that are important aspects of what is needed for users to function in that space and time.

“Noise” can also be sounds that attract users’ attention in an unwanted and uncontrollable way, such as sounds that begin/end abruptly, sounds that change tempo or volume in noticeable ways, sounds that are personally or culturally disliked or termed unpleasant, and so forth (see above discussion).

While clearly it is past time that designers control damaging noise levels and extraneous and distracting sounds, in addition, there is much more to consider when designing aurally effective and successful spaces. The typical focus on eliminating unwonted sound is a negative approach. But sound is more than noise. Understanding the many ways in which what we hear contributes to human experience repositions sound design as a positive activity.

We have seen that sound serves an array of human needs. Properly included in a space, sonic experiences are part of the very fabric of our lives. Each of the issues addressed in the above discussion demonstrates the ways in which well-designed aural architecture responds to and supports human needs. Professionals in the world of sound and hearing – both those doing research, and those functionally using sound in spaces such as designers, acousticians and sound artists – can be pro-active on this issue, working with accrediting groups that are focusing on sonic experiential quality, such as the Well Building Standard. We can make certain that sonic standards go beyond noise amelioration and recognize the wide variety of sonic experiences that are important for human functioning and thriving.

Often too little appreciated is the contribution made by sound artists, particularly those composing sound art to be placed in specific places, to human well-being. We need art in our lives to thrive, to encourage imagination and creativity, to connect us to our emotions, to ground us in the spaces we inhabit and thus turn space into place. Sound artists can use the above examples of how sound is perceived, experienced and utilized to expand their palette of sonic experiences to produce ever-more interesting and stimulating sonic compositions.

We can encourage space designers to truly broaden their awareness of the range of spatial sonic experiences and thus gain appreciation for the crucial role played by sound. Once space

designers come to appreciate the complex role of sound and hearing in human functioning, researchers and designers will be in a better position to collaborate in the actual design process. This process begins in the education stage, by generating courses for both students and practitioners of space design, and urging these to be incorporated in designers' formal training.

Further, we need to bring into the mix social scientists, who can generate ways to measure the effectiveness of supposedly sonic-oriented spatial designs – it might look good, but it is functionally worthless if it doesn't sound good. But, how do we know when a design works and when it doesn't in the world of real-life/real-time human experience? Research-oriented social scientists can help to answer this question.

In addition, spatial designers and sound-and-hearing professionals must recognize the importance of cultural values around hearing sound in space. Maximizing economic return at the expense of permanent hearing damage is not a good long-term plan; in the end, society pays in both health care costs and in lost human functioning and well-being. We need to elevate the value of support and expansion for positive human experience and human functioning to be on a par with financial return. For example, including high quality auditory experiences through the arts provides a valuable return in human well-being and high functionality.

Finally, we must make sure that those who design and organize the use of sonic spaces become aware that social rules of behavior shape human activity, including the levels and types of sounds that each socio-cultural group favors. We need to include the general public as partners in valuing and using functional and supportive sonic designs. For example, we would look for partnerships with those individuals and groups who suffer with poor quality sonic spaces, and would instead thrive with high quality sonic spaces, for example workers in intrusively noisy open-office designs, or servers in cacophonous restaurants. These groups can work with sound professionals to influence the sonic designs of their spaces. Thus we not only need to adjust physical architectural design, but also develop what Thaler, Sunstein and Balz have termed "choice architectural design."[21] Choice architecture refers to specifically organizing the social and cultural context within which people make decisions so as to push, or nudge them towards making certain types of decisions.

In terms of sonic spatial rules of behavior, this would mean making safer and more supportive choices about sound quality in space, guiding expectations for sonic spatial design, suggesting

which sonic spatial qualities to demand from space designers, and most importantly, provide templates for evaluating space in terms of its aural qualities and the effect on users' quality of life.

The more we understand about the role of hearing sound in space in human functioning and human thriving, the more our work will move into the mainstream of everyday human living.

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