The unexamined rewards for excessive loudness

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INTRODUCTION

Throughout the centuries and across cultures, the battle to reduce disruptively loud sound has met uneven success, even though the social and biological consequences are well known. As far back as the 14th century, an anonymous European poet complained of excessive street noise (Gimpel 1977). An 18th century print by William Hogarth, *The Enraged Musician*, depicts indignation when street sounds invade his studio. Thompson (2002) provides a summary of the political failure to manage noise pollution beginning in the late 19th century. Recent studies reveal that personal knowledge about the dangers of loud music is frequently insufficient to change behavior (Miller et al. 2007; Rawool & Colligon-Wayne 2008). Other studies described the physical, social, cognitive, and emotional consequences of hearing disabilities (Arlinger 2003; Zimbardo et al. 1981; Roth 1955), which often result from repeated exposure to loud sound.

Although social and medical experts have experimented with different strategies for changing attitudes toward damagingly high sound levels, success has been, at best, uneven. There are numerous examples where individuals willingly choose to immerse themselves in recreational sound fields that destroy hearing. In these venues, sound levels are well above the limits set for occupational settings. Examples include popular music concerts, advertising in cinema theaters, battles in aggressive video games, corrosive acoustics in restaurants, amplified music in dance clubs, motorcycles with disabled mufflers, enhanced automobile sound systems, and portable music devices with a direct connection to the ear canal. In many of these venues, the result is self-inflicted damage to the auditory system.

To strengthen the battle against disruptive noise, we suggest reversing the question: rather than focusing exclusively on the dangers of loudness, we ask why individuals consciously choose to immerse themselves in destructively loud sound fields, especially in recreational venues? Discussions about the negative consequences of these environments are incomplete if we do not acknowledge that excessive loudness produces personal rewards.

A review of the literature reveals two major classes of rewards, which we call *Altered States of Consciousness* and *Controlling the Experience of Social Space*. In both cases, individuals use loudness as a means of influencing their interior and exterior environments. Loud sound carries symbolic meaning, representing such qualities as energy, dominance, spatial ownership, and the psychological freedom to be transported to another place. Because loud music has more emotional impact than soft music, loudness intensifies sensory experience and manipulates listeners' emotional states. In addition, loudness is an important mechanism for achieving social and spatial control by overriding social interactions and physical boundaries.

We argue that there exists a personal reward system for loudness, and that its existence explains the difficulty in changing behavior. Positive rewards suppress recognition of the negative consequences. Moreover, the rewards are immediate, while the costs are subtle and delayed for years. This time imbalance skews the

trade-off between damage and pleasure. Based on the behavior of individuals in the 21st century, we appear to be loosing the battle.

When a culture accepts loudness as being a legitimate right in recreational sound venues, that acceptance tends to legitimize all forms of noise pollution. As a culture with advancing sonic tools and amplification, there are increasing opportunities to be immersed in destructively loud sound fields. We believe that acceptance of loudness in entertainment then carries over to a tolerance of disruptive noise from airplanes, jackhammers, powered garden equipment, and so on. Loudness becomes the cultural norm. We hope that understanding the rewards of loudness will lead to better strategies for changing our culture.

Loudness connects evolution, biology and culture

The roles of the various senses depend on culture rather than being a biological imperative. In earlier cultures, hearing was the dominant sense for experiencing the world (Howes 1991; Ong 1982). Hearing can only be understood when cultural relativism is also included, which is part of sensory anthropology. The Hausa people, for example, recognize only two senses: seeing and experiencing life, which itself encompasses intuition, emotion, smell, touch, taste, and sound (Ritchie 1991). They use vision primarily for avoiding obstacles. Even in the 20th century, rural citizens relied on sound for connecting to events (Schafer 1978).

Because sound flows over long distances, and because it is not obscured by objects, hearing was a critically important means of survival for early humans. Sound allows for the detection of objects and dynamic events without depending on light. The auditory system for mammals is active 24/7 because there is neither the equivalent of ear-lids nor controlled focus. Loudness is a measure of distance, power, and relevance. For example, both running elephants and falling boulders have high energy levels and are more likely to pose a threat than low energy events. As a species, we are wired to have a strong response to loud sound because intensity is an indicator of a significant dynamic event that is nearby and/or of high energy level. The linguistic label of “size” for typical environmental sounds includes the dimension of loudness (Kidd and Watson 2003). In addition, by detecting important sonic events, the auditory system can steer the visual system to focus on the location of critical important events. Knowing about such events had survival value.

Loudness is so important that there are brain substrates that are particularly sensitive to rising sound intensity, which serves as an early warning that a sonic event will become loud. From an evolutionary perspective, estimating the rate of arrival of approaching sound-sources (such as dangerous animals) in natural environments had survival value. Seifritz et al. (2002) commented: “The prioritization of rising sound intensity…modulates attentional and space recognition processes and, as such, is likely to provide an adaptive advantage.”

In combining knowledge of neurobiology, musicology, and psychology, Huron (2006) offers a unifying theory. In his view, human emotions arise from an activation of the brain stem (so called reptilian brain) to produce biological readiness for a flight, fight, or freeze response. But after a sensory trigger prepares the organism for one of these fast responses (arousal), the high level cortex may then assess the situation as being innocuous. Arousal unconsciously originates as fear, even when we consciously know that there is no danger. This is perhaps akin to the fearful pleasure of riding a roller coaster or watching a scary movie. Since the auditory system is connected to numerous other brain substrates, loud sound is a major source of

arousal, which is then experienced as a positive emotion. Increasing the intensity of a sound, which elevates arousal, then increases the magnitude of the physiologic response.

Altered states of consciousness

While the phrase "altered state of consciousness" acquired a negative meaning during the drug culture of the 1960s, we all engage in manipulating our emotional and psychological state whenever we choose particular stimuli. From this perspective, there is no unaltered state of consciousness because all stimuli, be they exercise, sunshine, sugar, alcohol, or music, change an individual's internal emotional and psychological state. We depend on a sensory connection to the external world. When fully deprived of sensory input, psychological disintegration takes place within a few minutes (Cohen et al. 1965); sanity requires sensory stimulation.

Strong personalities are well aware of their ability to manipulate the emotional state of others through sound. The role of a shaman, especially in the use of music for creating trance states, has a long history that can be traced back to the ancient Greeks (Rouget 1985). Preachers, politicians, disc jockeys, salesmen, and demagogues manipulate people with sound that appeals to their unconscious sensitivities. Independently of the message's content, loudness communicates an orator's passion, sincerity, and conviction.

Musicians and composers use sound intensity as a musical attribute that complements pitch and timbre. Patel (1996) noticed that a message on the inside cover of the album *Disintegration*, advises that "this music has been mixed to be played loud so turn up the volume." Composers of western music use increases in sound intensity to influence the listener's internal state (Huron 1992). Berlyne (1961, 1971) theorizes that stimulus preference is a function of physiological arousal, which depends on intensity. Sounds that are complex and intense increase arousal and are generally preferred over simplistic and weak sounds. For both music and speech, loud excerpts were judged as being more pleasant, energetic, and tense than soft excerpts (Ile & Thompson 2006). Loud music produces high levels of arousal, especially when the music matches the individual's preference (Gowensmith & Bloom 1997).

Changes in the emotional state are often observed with concomitant changes in physiology. Huron (2006) observed that the phenomenon of music-induced "chills and goose bumps," called frisson, depends on loudness. Excitative music produces feelings of vigor and tension, accompanied by the physiological responses of increased heart rate, respiration, and blood pressure (Iwanaga & Moroki 1999). Tolerance to pain shifts with music (Mitchell & MacDonald 2006). Increased loudness of music makes time appear to slow down and events to last longer (Kellaris 1996).

Loudness changes an individual's psychology and behavior. Loudness represents power, which may be a form of machismo, like flexing muscles. Fligor & Ives (2007) observed that men prefer louder music than women. Rentfrow & Gosling (2003) suggest that "individuals who listen to heavy metal music at loud volume with their car windows rolled down may be trying to convey a 'tough' image to others." A motorcyclist driving through a suburban town at 3 o'clock in the morning is clearly demonstrating his power to wake a large number of people. By raising the arousal state, loud music increases the quantity of alcohol consumption among adolescents (van de Goor et al. 1990). Males consume more alcohol than females when listening

to loud music (Guéguen et al. 2004). Young tennis players consciously selected music to elicit various emotional states to improve their mood, increase arousal, and provoke imagery (Bishop et al. 2007). A study of music levels during aerobic exercise revealed that music intensity was related to enjoyment and provided an increased motivation to engage in energetic exercise (Wilsont & Herbstein 2003). For those exercising in a quieter class, they reported that the music was too soft, which made them enjoy the class less and not work as hard.

Similar results were found in studies of portable walkmans, live concerts and nightclubs: intensity relates to enjoyment and motivation. Disc jockeys, who have control over both the music selection and sound levels in nightclubs venues, willing subject themselves to average sound levels of 96 dB(A) with peaks of 108 dB(A) (Bray et al. 2004). When questioned, more than 50 % of adolescents approved of the sound levels at discotheques that they visited (Weichbold and Zorowaka, 2005). More than 50 % of a sample of listeners at a music festival considered a sound level of 100 dB(A) to be acceptable or too low (Mercier et al. 2003). Curiously, toddlers aged 2 to 3.5 years also show an innate preference for fast and loud music, compared to slow and quiet music (Lamont 2003), perhaps as a form of a self-medicating stimulus.

Todd and Cody (2000) provide evidence that activation of the vestibular system may be evoked with sound stimuli above 90 dB and with frequencies between 100 and 300 Hz. Such sound is typical of dance clubs and rock concerts. Moreover, the threshold for vibrotactile sensations is lowest for frequencies of 200 Hz. This is consistent with elevated bass so that listeners can “feel” the music, especially in the context of dancing and synchronized motion.

Various researchers have postulated that brain activity and hedonistic stimuli are linked; individuals regulate their level of sensation to achieve optimal hedonic tone (Tucker et al. 1990). Adolescents explain their preference for listening to music at high intensities because it produces bodily pleasure (Vogel et al. 2008). Bill Thompson (2008), a professor of psychology at Macquarie University, explained that people tend to want more of anything that has a positive valence, and loudness is simply a way to amplify the intake of a desired emotion. From their study of the neurological response to emotional music, Blood & Zatorre (2001) commented that “music recruits neural systems of reward and emotion similar to those known to respond specifically to biologically relevant stimuli, such as food and sex, and those that are artificially activated by drugs of abuse.” Increased intensity usually increases the response to positive stimuli.

Some young adults who listen excessively to loud music have been observed to have maladaptive patterns similar to that exhibited by substance abusers, such as alcohol addiction (Florentine et al.1998). Some subjects in the study described withdrawal symptoms when trying to stop listening to loud music. Any class of stimuli that creates a pleasurable internal state has the potential to become addictive. Loudness, acting as an intensifier of pleasure can then becomes addictive.

Tolstoy (1890), writing in the 19th century, summarizes our view of music at high intensities: “Music makes me forget myself, my true condition, it carries me off into another state of being, one that isn’t my own; under the influence of music I have the illusion of feeling things that I do not feel, of understanding things that I do not understand, being able to do things I’m not able to do.” This quotation is not unlike that of those who describe a psychedelic high on drugs. Loudness amplifies the

experience for those who seek this kind of response. It applies not only to music, but also to a passionate sermon, political speech, and gunshot in a video game.

Controlling the experience of social space

While sound changes an individual's emotional and psychological state, such changes are also an adaptation to the environment. Sound connects human beings directly to sonic events, and they both exist in the external environment. On the one hand, spatial acoustics influences our experience of sound sources, and on the other hand, sound is a means of experiencing space itself. As discussed in our recent book (Blesser & Salter 2007) on aural architecture, space and sound cannot be separated.

Each sensory modality creates its own sensory space, which need not be consistent with other sensory spaces. A person can exist in a visual space, aural space, tactile space, olfactory space, and so on. To appreciate the difference between an aural and visual space, consider two examples of a box over your head. In the first case, the box is made of glass, while in the second case it is made of black cloth. With a glass box, you have a small aural space but a large visual space, and conversely, with the cloth box, you have a large aural space but a small visual space.

Examining aural space is challenging. Sound is ethereal; it does not leave physical evidence of its previous existence; it's hard to accurately recall; and there are few words to describe it. An aural space is empirical because its boundaries are based on our ability to hear sonic events occurring within it. Aural space exists from the perspective of the listener. If you can hear a sonic event, then it exists within your aural space, but if you cannot hear the event, it is outside your aural space. The boundary delineating the space is thus experiential, rather than physical, and is called the *acoustic horizon*.

There are numerous examples of how the acoustic horizon is determined by the loud sounds. In his study of 19th century French villages, Corbin (1998) described how hearing the town bells were the basis for citizenship. Those that could hear the bells were rooted in the social fabric of the town with enhanced self-esteem and civic pride. Because louder bells created a larger and more powerful community, metallurgy technology was the equivalent of military power in being able to expand the area of the town. You were a citizen of the town if the bells existed within your aural space.

In a quiet home, you can hear your footsteps on a hardwood floor and thus your feet are part of your aural space, but in a noisy city you cannot hear your footsteps. Your aural space has shrunk, and your feet are outside your space. Before a concert begins, you can hear the breathing of your friend sitting next to you, but after it begins you hear nothing other than the music. Loud sounds mask all other sounds, thus making a listener functionally deaf to everything else. Before the music, your friend was part of your aural space. Once the music begins, the sound of your friend's breathing falls outside your acoustic horizon.

Loud sounds can capture our perceptual system, often overcoming other sensory information about the physical space. For example, loud music transports listeners from the physical and social space of their surroundings to the musical space of the performers. When the motorist in a car raises the volume of music, he is transported out of the road space and into the virtual space created by musicians and sound engineers. Listening to music with earphones blocks extraneous environmental sounds, transporting the listener to an entertaining music space. In NYC, three people wearing headphones were killed when they unheedingly stepped into the

physical space of the street while existing in an experiential musical space. Loudness is a space transporter because people become functionally deaf to their immediate environment if the virtual environment has louder sounds.

Advertisers presenting messages on television and before movies raise the volume relative to the regular entertainment. They know that loudness helps to sell because the listener cannot focus on other events. While eyelids provide the individual with voluntary control to select what is being seen, there are no corresponding earlids to control what is being heard. Humans are coupled to their aural space without being able to be in control of its size or its content. Sound often manifests itself in a Darwinian combat: loud sound is like the stronger "animal," winning the battle over space and resources. Advertisers know that whoever produces the loudest sound controls the space.

Musicians performing in a live venue frequently find that they are simultaneously living in two or more spaces. On the one hand, the sound from headphones embeds musicians in their electronic music; on the other hand, environmental sounds connect musicians to real people in a real space. How can a musician transport himself, at will, from one space to the other? To a large extent, the only control mechanism is loudness. The louder space dominates. There is no biological means for controlling sound intensity, but electronic amplification allows headphone space to dominate an environment space. Because loud sound suppresses awareness of the internal space of daydreams, images, and self-generated sounds, people often use sound to help them focus on mental tasks.

Petersen (2007) argues that in-ear headphones can be used to make the musical space dominate the environmental space by creating sound levels above 140 dB, which is very dangerous. Such levels are not accidents. Consider the case of a fully packed nightclub with intoxicated listeners, and consider that the musician's headphones do not block out the audience noise. To be exclusively in the musical space, the musician may choose high amplification to mask unwanted ambient sound. In some cases, musicians will blast one ear with their amplified music while leaving the other ear for the sounds of the environment. Just as we switch our attention at a dinner party among various dialogs, these musicians switch between their music and their audience of screaming fans.

There is one last example of loudness as a means of controlling attention among competing sonic elements. Amplification of music makes subtle aural nuances, which are relatively quiet, more apparent. Musicians may listen to the music at high intensity in order to focus on such otherwise inaudible nuances as the bowing noise of a violin; and similarly, audio engineers use loudness to focus on technical artifacts of the mixing process and the balance among high frequency overtones.

SUMMARY AND CONCLUDING COMMENTS

An aural space with loud music is often experienced as "exciting" because loudness creates emotions and arousal. Because sound is always associated with a dynamic event that requires energy, loud music is equivalent to intense energy. In our pre-electronic world, creating a loud sound always required intense physical exertion, as for example, loud drums require violent pounding. We respond to the implied physicality of loudness, even though electronic amplification only mimics physical exertion. From an evolutionary perspective, we still respond to loudness as if it represented a big event that was relevant to our survival. Loudness gets our attention.

We believe that changing attitudes towards the physiological destructiveness of loud sound requires an acknowledgment that there are rewards for doing so. Like everything else in life, there are trade-offs between the advantages and disadvantages of a particular behavior. But by focusing only on the negative, an advocate is unlikely to get attention. A successful dialog requires an open discussion, and this is best done with understanding and empathy. Focusing on the negative is a form of criticism and castigation, which is seldom heard. Acknowledging the rewards of loudness is the basis for negotiating between the rewards and the costs. We end with the critical question. If loudness produces immediate social and emotional rewards, are there less damaging alternatives that produce the equivalent rewards?

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