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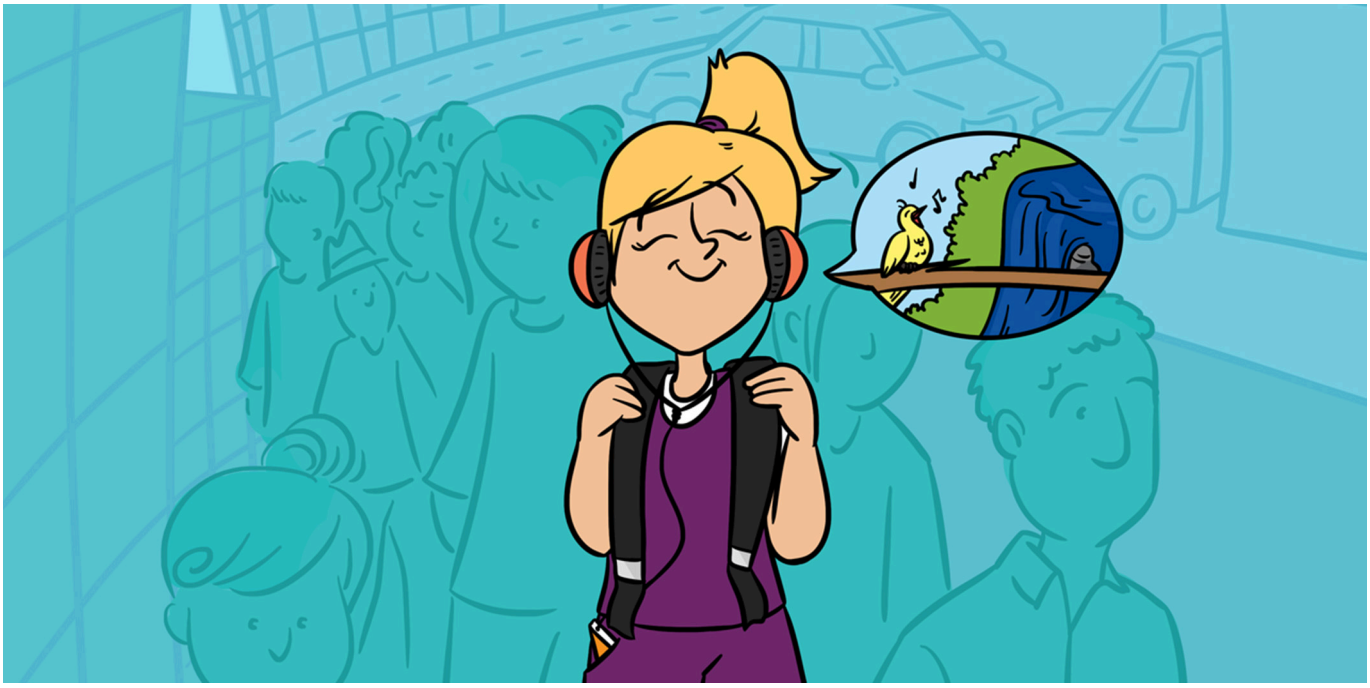
HUMAN HEALTH
Published: 24 November 2022
doi: 10.3389/frym.2022.910059



THE SOUNDS AROUND US IN CITIES AND BUILDINGS

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Sound surrounds us every day, whether we are inside buildings or moving around our cities. But what is "sound" and what is "noise?" What effects can arise from exposure to one or the other? This article will introduce the complex and fascinating world of sound, highlighting the opportunities that acoustic scientists have to reduce noise pollution and to design cities and buildings that sound good to our ears, to improve people's health and wellbeing.

SOUND VS. NOISE

No matter how hard we try, we will never find a place that is completely silent. If something moves, it produces a sound—even if humans cannot hear it. Sounds are everywhere, all around us. The sounds we usually notice are produced by people or by things that people use. Think about road traffic or industries, for instance. Yet, nature can be very loud too! Imagine how noisy an erupting volcano or a tornado might be!

In general, sounds are neither good nor bad. What listeners think of them, though, makes all the difference. If a sound makes us unhappy or annoyed, we think of it as **noise**. The word "noise" comes from the Latin word "nausea," which actually means seasickness. When we listen to a sound that we do not like, it makes us feel uncomfortable, hence "sick." But noise might just be a sound in the wrong place or at the wrong time.

NOISE

A sound that makes one unhappy or annoyed, with the potential for more severe adverse health effects.

In cities, we often talk about noise pollution, which refers to noise levels that make some people unhappy. You might be surprised to learn that noise is not a modern problem. Many cities of the past were also noisy places. Back in the sixth century BCE, the ancient Greek colony of Sybaris was so noisy that the province's council told potters and tinsmiths that they must live outside the city walls because they were so noisy! As human civilizations developed, cities kept growing and became more crowded. Today, most people live in towns and cities and with more people comes more noise! In fact, the World Health Organization (WHO) reported that, in Europe, around one out of every five people are exposed to noise levels that are too high and potentially dangerous for their health.

MEASURING SOUND

When it comes to sounds, how loud is too loud? How noisy does a noise have to be before it is a problem? Noise levels are usually measured in a unit called **decibels** (dB).

DECIBEL

Unit used indicate the intensity or loudness of a sound, with louder sounds corresponding to higher dB levels.

Imagine a person standing a meter away from you, talking in a normal voice. The sound they produce would measure around 60 dB when it enters your ears (Figure 1). Measuring sound can be a very complicated business. This is because the decibel is a logarithmic unit, which means we cannot add or subtract decibel levels as we would with "normal" numbers. For instance, two sound sources emitting 50 dB each will not add together to produce 100 dB of sound, but instead would measure 53 dB!

The WHO has published recommendations on how much noise is acceptable in various places and circumstances. For example, imagine standing outside a house at night, with people sleeping inside. You are measuring the sounds around you with a microphone and a noise level meter. The WHO would say that road traffic noise should not be louder than 45 dB, railway noise should be no higher than 44 dB, and aircraft noise must be below 40 dB [1]. These limits are different because some noises are more annoying than others!

Figure 1

Sound level values for certain sound sources.

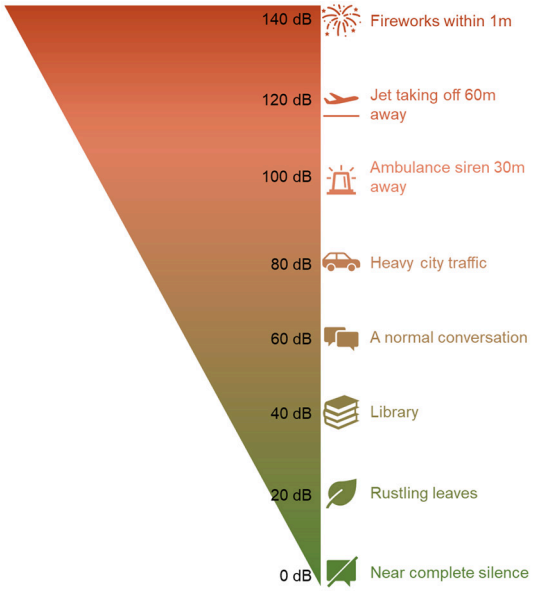

Figure 1

SOUNDS CAN ENRICH OUR LIVES

Most people would agree that a totally silent world might not be a pleasant one. Many sounds enrich our lives and make our everyday experiences interesting and meaningful. So, it is important that we do not always look at noise as a bad thing, or as a "pollutant"—some sounds can be positive [2]. For example, listening to natural sounds such as birdsong or running water can help reduce stress and improve wellbeing and mood [3, 4]. Try listening to the sound from London's Regent's Park in Video 1. How does it make you feel? Similarly, hearing music in public spaces can help people feel happier, more excited, and more connected to others. Try listening to the vibrant sounds of London's Covent Garden in Video 2. How do these sounds make you feel?

VIDEO 1

Sounds from London's Regent's Park. The recordings were sourced from the International Soundscape Database.

VIDEO 2

Sounds from London's Covent Garden. The recordings were sourced from the International Soundscape Database.

Some sounds may be so unique that they become a "soundprint" of a place. When we hear these sounds, we instantly know a lot about the location, without needing to be there or even see it. For example, many people would recognize the sound of a cheering football crowd and know it was coming from a football stadium during a match. Can you think of any other easily identifiable soundprints?

MANAGING INDOOR SOUNDS

So far, we have talked about cities and outdoor spaces. But many of us spend a lot of time *inside* buildings. We hear sounds from both *inside* and *outside* the rooms we are in. For example, if you are sitting on the sofa, you might hear laughter from the television, the footsteps of someone walking around upstairs, the rustle of the

wind in the tree outside the window, or the sound of a siren from the street beyond.

When we are inside, the sounds we hear travel through the air and may also travel through the walls of buildings, the glass of windows, or the materials that make up the ceiling. When sound hits a wall, part of the sound is reflected, part is absorbed by the wall, and the rest passes through the wall. Some surfaces are good at soaking up sound, while others work more like mirrors, reflecting sound.

If you have ever been inside a church or a large, empty school hall, you will know that the sound of your footsteps can seem very loud. This is because the sound your feet produce is reflected over and over again by the hard stone walls and floors. These reflected sounds reach your ears at slightly different times, depending on how far each reflection has traveled. The result is that you hear an echo that seems to bounce around the room. Sometimes these sound-reflecting surfaces are specifically shaped and positioned to direct the sound, for instance toward the listeners in a concert hall.

In contrast, soft, porous surfaces absorb most of the sound that hits them. The sound squeezes into the air-filled cavities of such surfaces, losing part of its energy in the process. You can find such **sound-absorbing** materials in cinemas, for example—soft seats, padded walls, and heavy curtains. These soft materials prevent echoes, making it much easier to understand and enjoy the movie. Other sound-absorbing materials include thin panels that vibrate when hit by sound waves, to weaken the reflected sound.

SOUND ABSORPTION

Phenomenon relating to the reduction of reflected sound when it hits a surface.

But what if we want to minimize the amount of sound traveling from one indoor space to another? One way is to look at "**sound insulation.**" Walls can provide good sound insulation, although some walls are better at reducing sounds than others! If you live in an apartment and can you hear your neighbors talking, singing, sneezing, or shouting, the walls might not provide very good sound insulation! Good sound insulators include materials that are rigid and heavy, with a continuous non-porous surface. An excellent strategy for creating a sound-insulating wall is to make it like a sandwich: the outer "bread slices" are made of rigid materials, while the inner "filling" is made of soft, sound-absorbing material.

SOUND INSULATION

Phenomenon relating to the reduction of sound transmitted through a wall or ceiling when it hits a surface.

When sounds and noises finally reach our ears, they are conveyed down our ear canals and picked up by special sensors inside our inner ears. These signals then travel to our brains, which process and interpret them in complicated and fascinating ways. Some sounds will capture our attention, while others will go unnoticed. Some sounds are so loud that they cover up quieter noises. This is called **acoustic masking**, and some places use acoustic masking to make noisy environments more comfortable. Have you ever been in a large, busy shop or cafe? These places are full of sounds: people talking, pots

ACOUSTIC MASKING

Phenomenon that occurs when the perception of one sound is affected by the presence of other sounds.

clanking, trollies being pushed around, tills pinging, and items being stacked on shelves. Many shops play music to mask these unpleasant sounds, to make your shopping experience more enjoyable.

AURAL DIVERSITY—EVERYONE IS DIFFERENT

When we are inside buildings, what is "sound" and what is "noise" depends on what we are doing at the time. The sound of voices might be pleasant while you are eating dinner or chilling at home, but annoying if you are at school trying to listen to your teacher. You might like peace and quiet while you are reading a good book, but if you are hanging out with friends, you might prefer to have loud music playing. Some of us prefer to study in silence, while others find it easier to concentrate with music or the television playing in the background. Some people prefer the quiet of the countryside, while others like the busy hubbub of a vibrant city. We call these differences **aural diversity**, which means that everyone experiences sounds in unique ways [5].

AURAL DIVERSITY

Difference in hearing between individuals.

However, there are some sounds that almost everyone likes. Many of these are natural sounds, like bird song or the sound of running water. Architects and engineers who design or modify buildings and outdoor spaces should think about the sorts of sounds people will hear in those spaces and how those sounds will be affected by the structures they are building. Because of aural diversity, there is no perfect "recipe" for everyone.

CONCLUSION

Environmental sounds are very complex, and while we might be tempted to think all noise is bad, the right noises and sounds can actually make our cities and buildings better places to be. **Acoustic scientists** help to measure sounds and determine which sounds are beneficial and which are harmful to our health. Architects and engineers can use these findings to design spaces that are pleasant and healthy. The right combinations of sounds or **soundscapes** [6], can help people to stay physically and mentally healthy, and even to thrive [7]. Measuring the loudness of sound is only one part of the story—we must also consider the types of sounds around us, how each type of sound moves about, and how all these sounds affect our thoughts, feelings, and emotions. The more we learn about sound and how important it is in our lives, the more likely we are to truly enjoy a world of sound.

ACOUSTIC SCIENTIST

A scientist who deals with the measurement and management of sound and its effects on humans, animals, and ecosystems.

SOUNDSCAPE

The sound environment that individual people perceive.

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SUBMITTED: 31 March 2022; **ACCEPTED:** 04 November 2022;
PUBLISHED ONLINE: 24 November 2022.

EDITOR: Chandrasekaran Jayaraman, Shirley Ryan AbilityLab, United States

SCIENCE MENTOR: Swati Goyal

CITATION: Aletta F and Torresin S (2022) The Sounds Around Us in Cities and Buildings. Front. Young Minds 10:910059. doi: 10.3389/frym.2022.910059

CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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