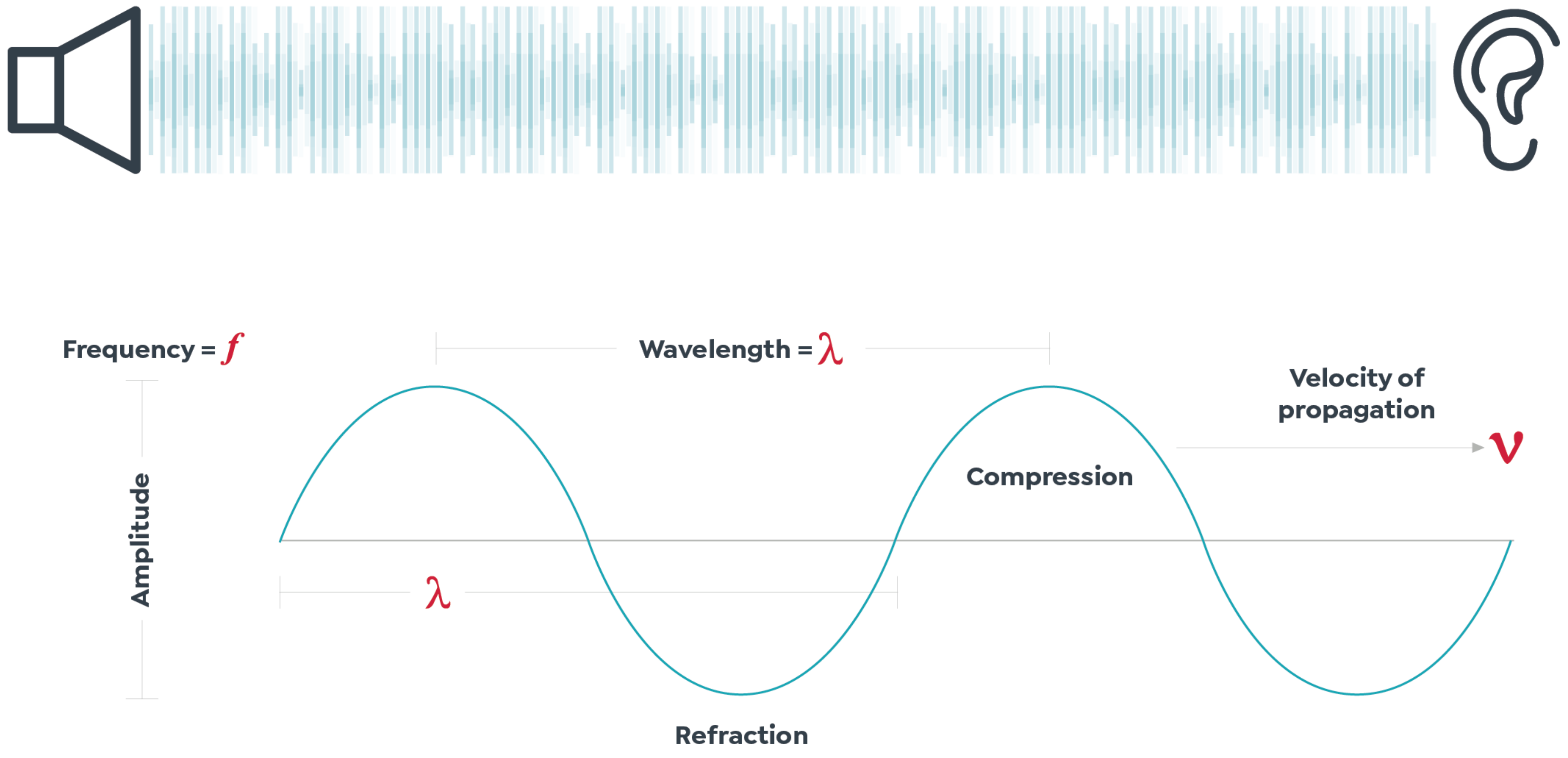
17/10/2023

Acoustic Jargon Explained: The Science of a Sound Wave.

By: Jared Hale

Do you know the difference between sound absorption and sound attenuation? Are reverberations and echoes the same thing? If you've ever felt out of your depth when an audiophile starts speaking, this article will help you get the confidence to at least fake it till you can make it.

Characteristics of a sound wave.



Soundwaves are notorious for reflecting off surfaces and creating echoes. Except in the case of pigeons. For some reason, sound from a pigeon doesn't reverberate when bouncing back off surfaces.

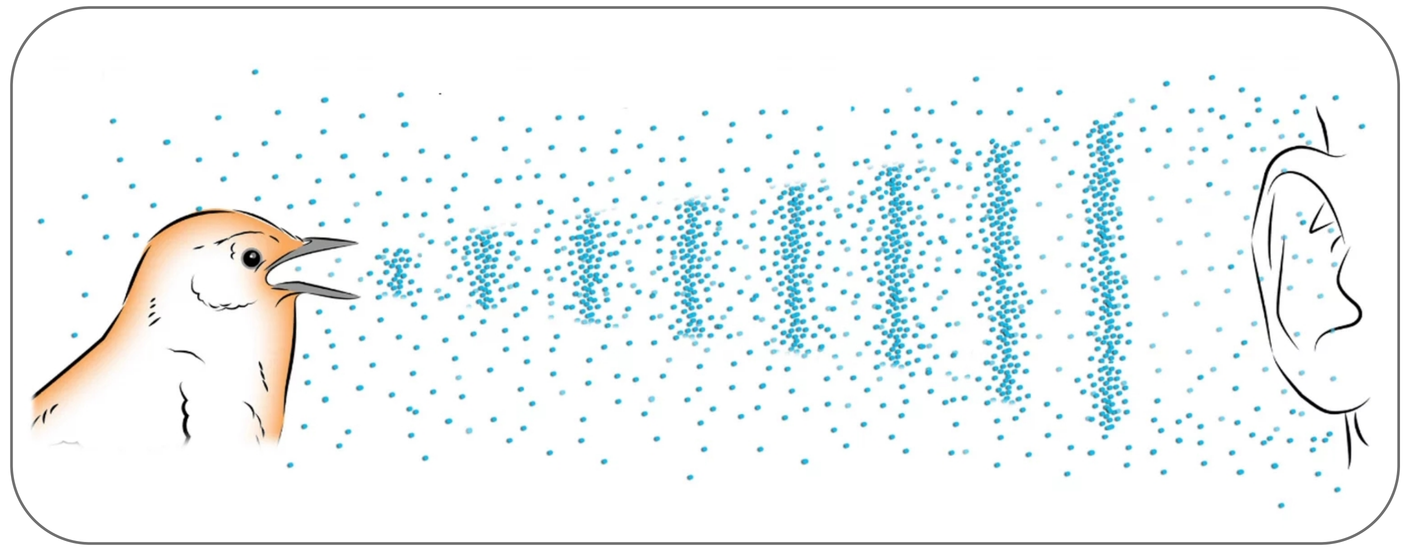
Scientists believe it's because a coo sticks.

That might *sound* funny, but unwanted noise is no joke. It's the reason why soundproofing products like Acoustiq have been gaining popularity over the past few years. But before you go plastering every wall with egg-carton foam, do you know what it is that you're doing? Do you know the difference between sound absorption and sound attenuation? Are reverberations and echoes the same thing?

If you've ever felt out of your depth when an audiophile starts speaking, this article will help you get the confidence to at least fake it till you can make it.

The Science of a Sound Wave

Everyone loves the sweet sounds of a singing songbird. Unless of course, that bird is a noisy miner who believes that 4 AM is now part of normal business hours. Regardless of the type of bird ruining your beauty sleep, all sound begins its life as a vibration.



When an object vibrates, it creates a disturbance in the medium surrounding it. This disturbance causes a chain reaction of movement in an outwards direction, much the same as ripples in a pond. Creating ripples takes energy, and so the further these ripples or "soundwaves" travel, the less intense they become. It's the reason why things are harder to hear the further away they are.

Speed of Sound

Medium	Speed (m/s)
Air at 0°C	331
Air at 20°C	343
Water at 20°C	1482
Lead	1960
Glass	5640
Steel	5960

Other factors can also impact how sound waves move through the environment. Sound waves travel faster in denser substances because neighbouring particles easily bump into one another. Let's take water, for example. There are about 800 times more particles in a bottle of water than there are in the same bottle filled with air. This extra density means that sound waves travel much faster in water than they do in air. In freshwater at room temperature, for example, sound travels about 4.3 times faster than it does in air at the same temperature.

So, that's all well and good for soundwaves that travel ***through*** different materials, but how about when the material pushes back?

Soundwaves are notorious for reflecting off surfaces and creating echoes. Except in the case of pigeons. For some reason, sound from a pigeon doesn't reverberate when bouncing back off surfaces.

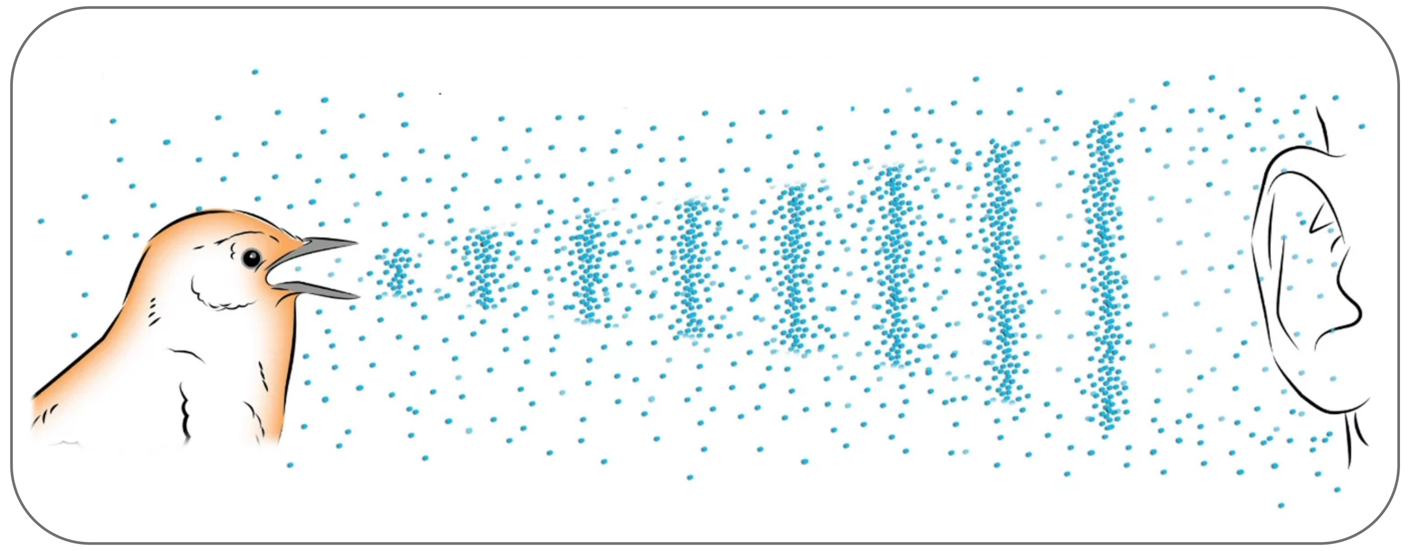
Scientists believe it's because a coo sticks.

That might *sound* funny, but unwanted noise is no joke. It's the reason why soundproofing products like Acoustiq have been gaining popularity over the past few years. But before you go plastering every wall with egg-carton foam, do you know what it is that you're doing? Do you know the difference between sound absorption and sound attenuation? Are reverberations and echoes the same thing?

If you've ever felt out of your depth when an audiophile starts speaking, this article will help you get the confidence to at least fake it till you can make it.

The Science of a Sound Wave

Everyone loves the sweet sounds of a singing songbird. Unless of course, that bird is a noisy miner who believes that 4 AM is now part of normal business hours. Regardless of the type of bird ruining your beauty sleep, all sound begins its life as a vibration.



When an object vibrates, it creates a disturbance in the medium surrounding it. This disturbance causes a chain reaction of movement in an outwards direction, much the same as ripples in a pond. Creating ripples takes energy, and so the further these ripples or "soundwaves" travel, the less intense they become. It's the reason why things are harder to hear the further away they are.

Speed of Sound

Medium	Speed (m/s)
Air at 0°C	331
Air at 20°C	343
Water at 20°C	1482
Lead	1960
Glass	5640
Steel	5960

Other factors can also impact how sound waves move through the environment. Sound waves travel faster in denser substances because neighbouring particles easily bump into one another. Let's take water, for example. There are about 800 times more particles in a bottle of water than there are in the same bottle filled with air. This extra density means that sound waves travel much faster in water than they do in air. In freshwater at room temperature, for example, sound travels about 4.3 times faster than it does in air at the same temperature.

So, that's all well and good for soundwaves that travel ***through*** different materials, but how about when the material pushes back?

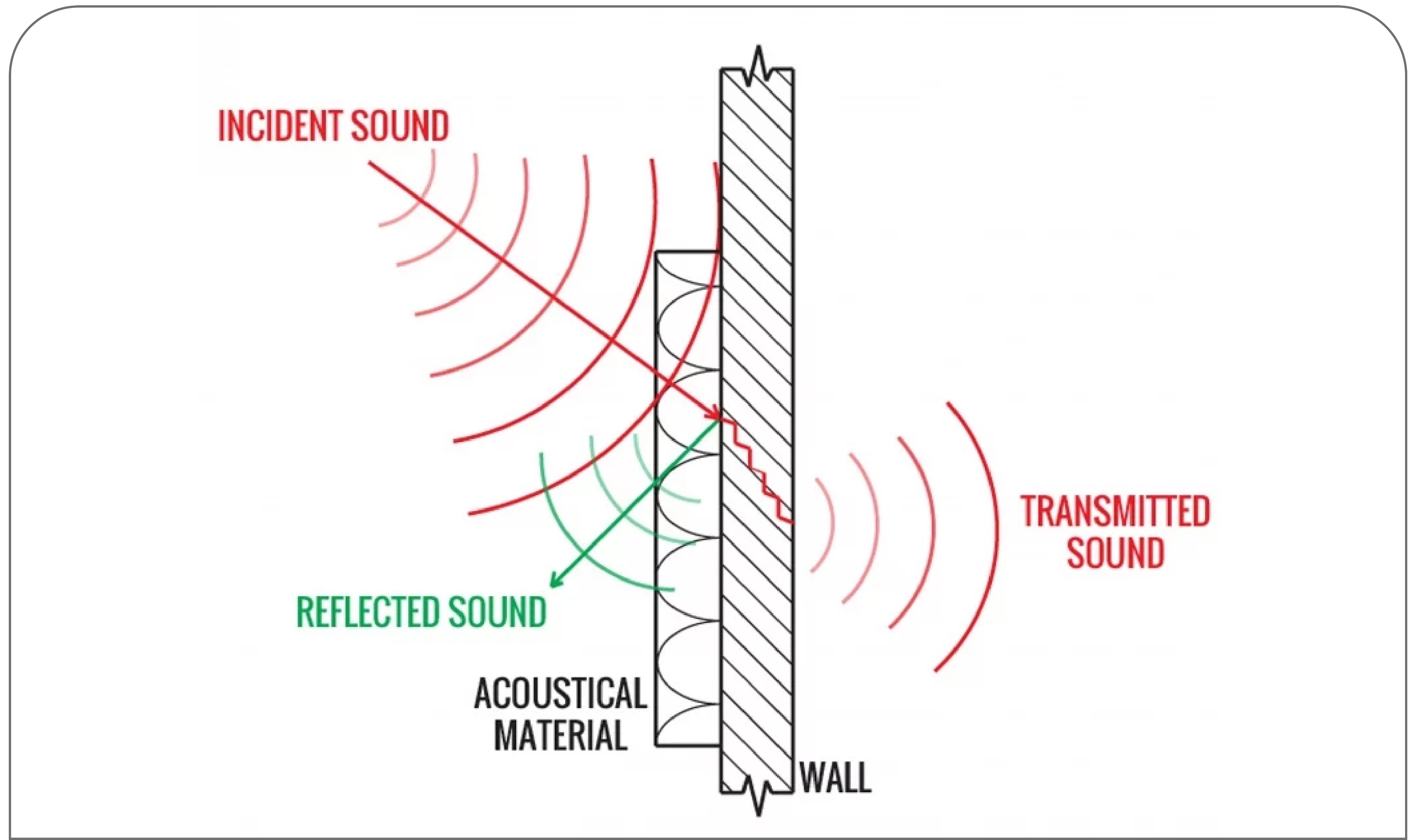
Reflection: The Sonic Bounce

Throw a tennis ball at a wall and what happens? Unless there has been a fundamental change to the law of physics, that ball should bounce back towards you, albeit with slightly less force that it left your hand with.

Similarly, when soundwaves meet a barrier, be it a wall, floor, or ceiling, a portion of it will reflect with the same angle of incidence.

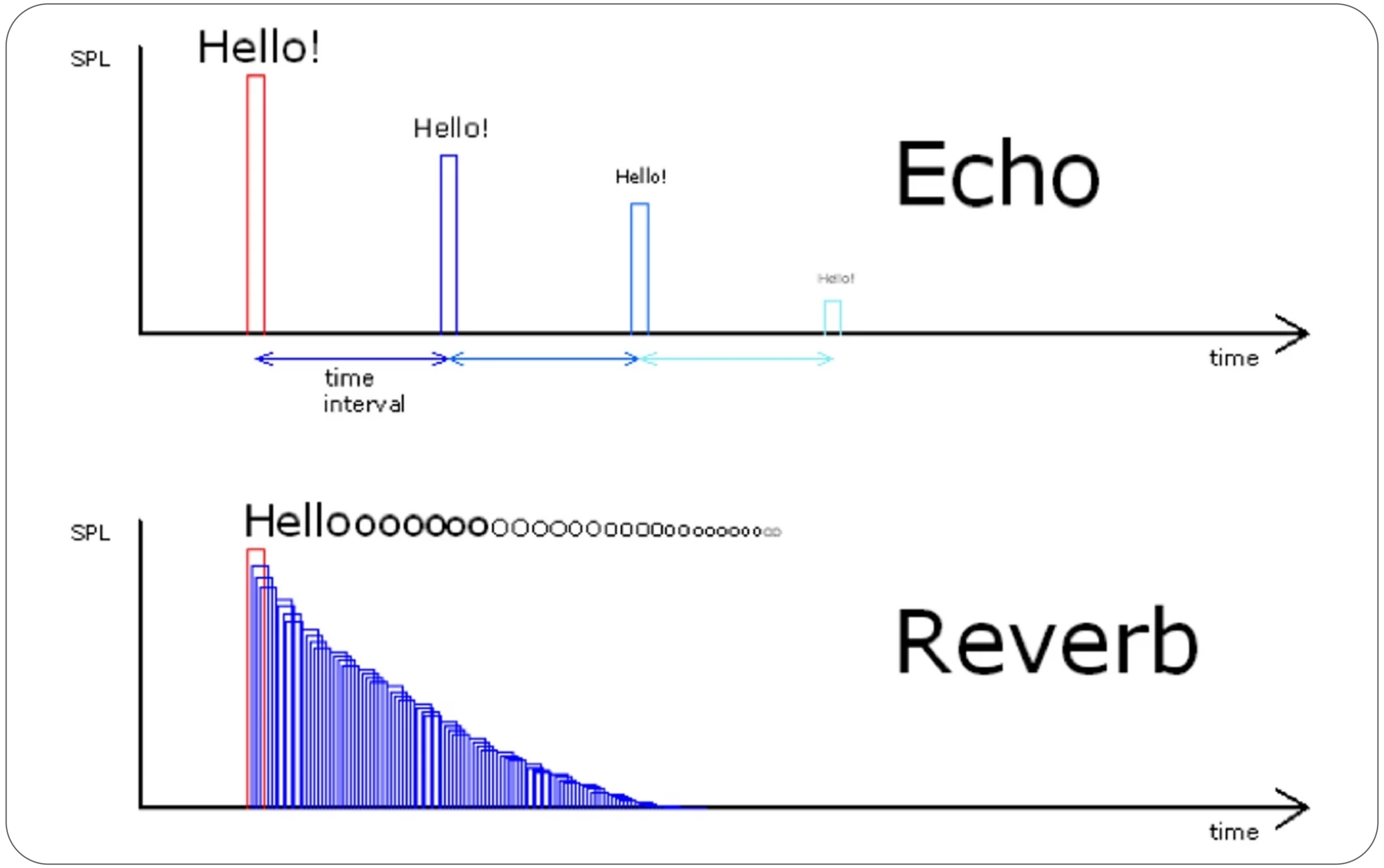
Just like with a rebounding ball, the reflected sound will have lost power, with some of the soundwaves being absorbed into the barrier and some transmitted through.

The part of the soundwave that bounces back is called **reflected sound**. The portion of soundwaves that passes through the medium is called **transmitted sound.**



Echoes or Reverb?

When a soundwave reflects off a surface, it creates one of two possible phenomena – an **echo** or a **reverberation**. An echo is described as the reflection of a soundwave, delivered to the listener with a slight delay. Reverberation, on the other hand, refers to the superposition of multiple echoes that creates a “prolonged” or “widened” effect to the sound being heard.



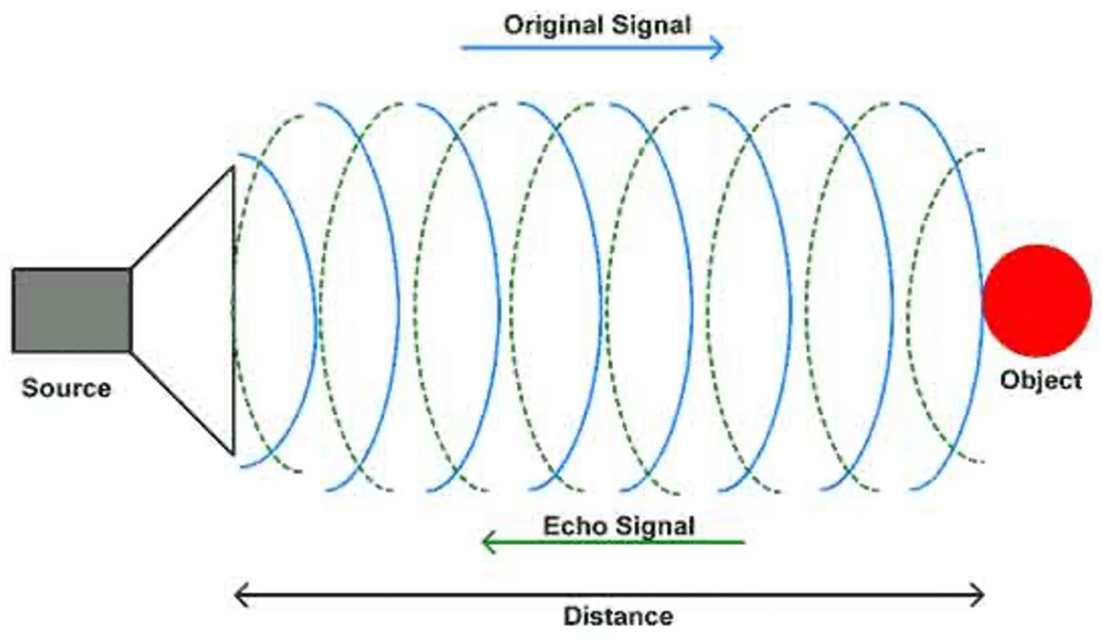
Think the different sounds you'd hear yelling in an empty carpark versus singing in your bathroom. In the carpark, you can hear a distinct and regular repeating of the initial sound that gets softer with each echo. When you're singing in the shower, the "widened" effect on your voice can easily fool you into thinking you're a good singer.

Now while the reflection of soundwaves usually creates a mixture of echo and reverb, the amount produced is largely dependent on the size of the space where the sound is being propagated.

◉ **Reverberation** often occurs in a small room with height, width, and length dimensions of approximately 17 meters or less. But why this seemingly random dimension?

The human brain keeps a sound in memory for up to 0.1 seconds. If a reflected sound wave reaches the ear within 0.1 seconds of the initial sound, then to that person, the sound is prolonged, or has continued without interruption. Since soundwaves travel at about 340 m/s through air at room temperature, it takes approximately 0.1 seconds for a sound to travel the length of a 17-meter room and back.

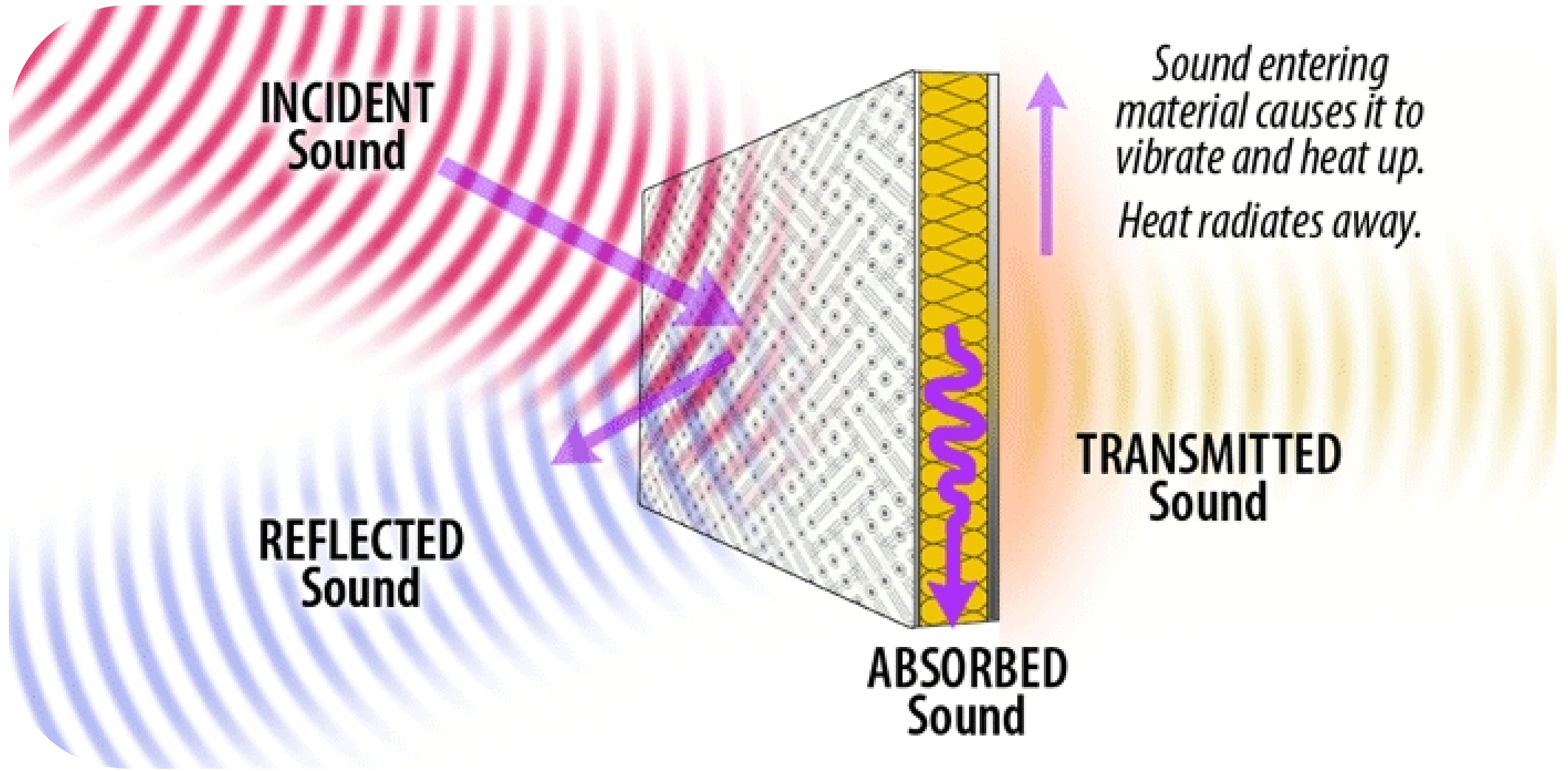
◉ **Echoes** occur when a reflected soundwave reaches the ear more than 0.1 seconds after the original sound wave was heard. In this case, the arrival of the second sound wave is perceived as a separate, second sound rather than a prolonging of the first sound.



Absorption – So Hot Right Now

We've already discussed what happens when soundwaves travel through a medium and how they reflect off barriers. But what about the portion of the soundwave that is absorbed by the barrier itself?

When a soundwave strikes a barrier, it causes the fibres or particle makeup of the barrier to vibrate. The resulting friction of these vibrations is converted into heat which is then dispersed through the material and eventually lost.

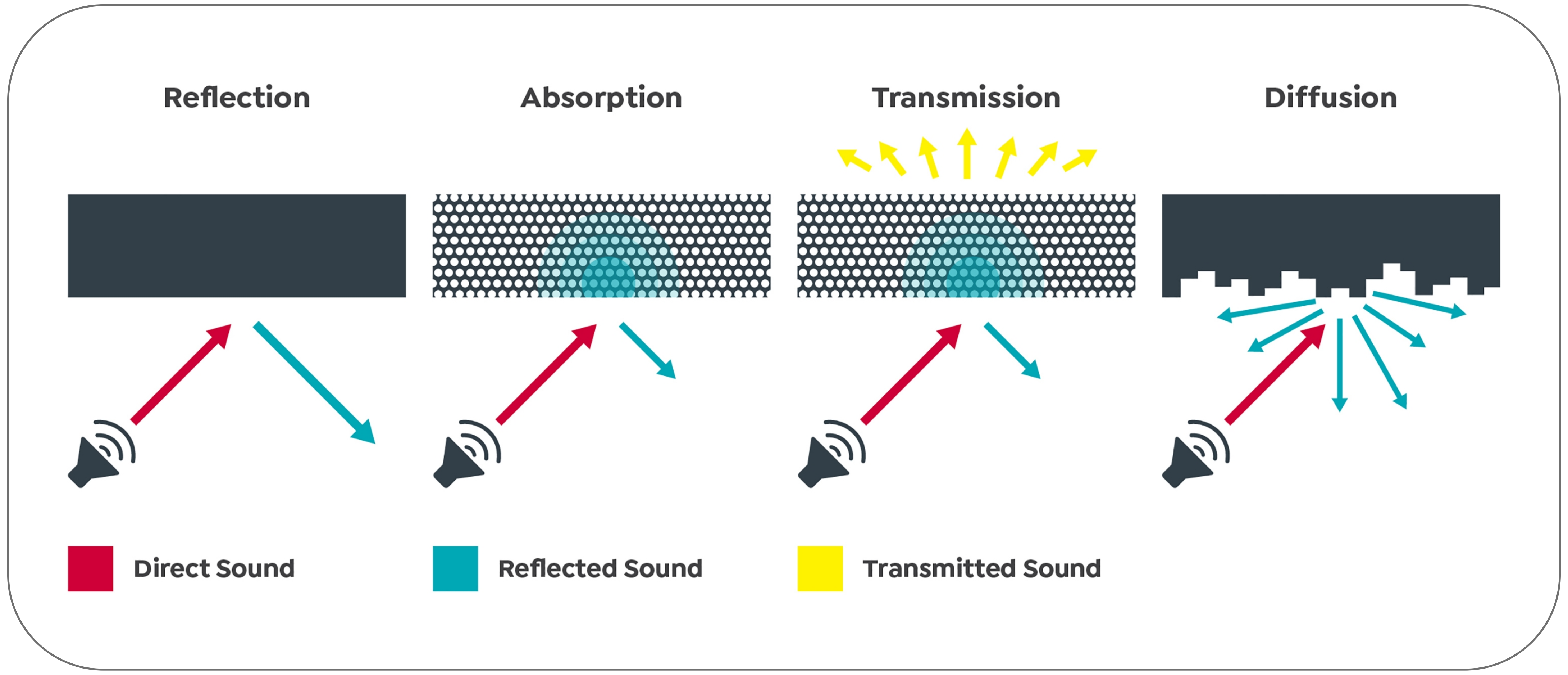


The properties of the barrier will determine how much sound is absorbed and which frequencies are more effectively captured.

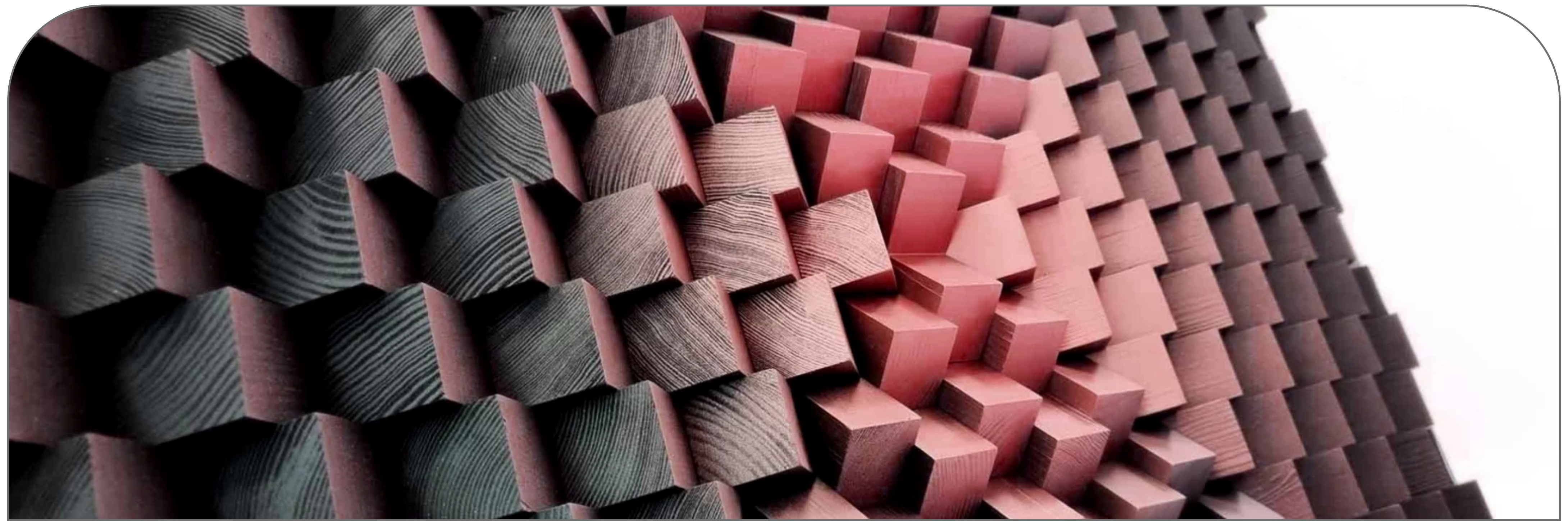
The more fibrous a material is the better the absorption. On the other end of the spectrum, denser materials tend to be less absorptive. While mid to high-range frequencies are easily absorbed with standard acoustic treatment, low frequency sounds are very difficult to absorb because of their long wavelength.

Diffusion – Scattered Sounds Good

So far, we've really only conceptualized what happens when soundwaves interact with flat surfaces. But what happens when soundwaves strike irregular shapes designed to confuse and scatter audio signals?



◉ **Diffusion** is the spreading of sound energy evenly in a given environment. This is usually achieved through the use of irregularly-shaped surfaces and strategically placed objects within a space.



A perfectly diffusive sound space is one in which the reverberation time is the same at any listening position. Most spaces aren't set up in this fashion, and in any given space, you're likely to find places where reverberations build on top of each other creating loud, audio "hotspots".

You'll find diffusion panelling in theatres, auditoriums, recording studios and other places where the perfect listening experience is paramount.

Acoustic Treatment – Hacking Your Space to Sound Amazing

There are many reasons people choose to include acoustic treatment to their place of work. From reducing ambient noise to creating private zones for meetings and confidential discussions, the sounds of silence go hand in hand with good acoustic treatment.

When designing your space, it's important to understand your options. Acoustic panelling has a range of different applications from ceiling baffles to privacy screens and everything in between.

Or for a truly serene solution, phone booths are a welcome addition to any office.

OLG Supports You.

As one of Australia's leading office furniture wholesalers, we do everything in our power to support our resellers. For a full list of everything we can do, check out How OLG Can Win You a Deal.

Stuck for ideas? Or maybe you just want an office furniture wholesaler that you can rely on. Feel free to give us a call at **02 8188 2732** or send us an email so we can discuss some more options.

Want to keep reading? Find out what's new with OLG or head over to the OLG Learning Centre. You'll find a curated archive full of educational articles and industry content, all completely free to use.