

SOUND IN THE MACHINE

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EPISODE TITLE

Rattle and Bump: How Sound Gets Around

TIME

9:25

DATE OF WRITING

20 February 2009 – 27 February 2009

PUBLICATION INFO

Date: 27 February 2009

Number: 5

Format: MP3

Location: Sound in the Machine.org

<http://soundinthemachine.org/2009/02/27/rattle-and-bump-how-sound-gets-around.aspx>

SUMMARY

The physical impact of sound energy. “That fleet of dump trucks that comes down your street Saturday mornings at 6, rattling your windows and spooking your dog, isn’t so much loud as it is transferring sound energy into the street, under your house and shaking everything right up to your bedroom walls, which then vibrate like so many massive speakers all around you.”

WORKS CITED

Pool meets Dominos. Very cool trick shot. <<http://www.youtube.com/watch?v=-Bgc67rf26I>>

SOUND SOURCES AND DESCRIPTION

- Spielberg, Steven. Back to the Future. 1985. (MP3 extracted from YouTube video <http://www.youtube.com/watch?v=feXM9Nml_74>)

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Rattle and Bump: How Sound Gets Around



published 27 February 2009 at soundinthemachine.org.

By Brian Snead

TRANSCRIPT

To kick off this episode, forget the idea that sound is the stuff you hear. I realize the difficulty: sound is pretty much exclusively an aural phenomenon and I'm asking you to forget about that. But rather than getting into lengthy explanations that are not likely to sink in as you listen to this, let's think big picture and get to the point. If we think of sound only as stuff for the hearing, we cut ourselves off to some of the really cool physical properties. Here's a quick run-down. Sound is what our brains make out of certain kinds of waves of energy after they have traveled through some kind of stuff, like air or water or bone or just about anything. The waves get their start from the movement of some kind of object or matter. If you've been adding it up, you know then that there are basically three components to make sound.

- First is the thing that releases energy.
- Second is the material that the energy travels through as waves.
- Third are our sense mechanisms, like ears and skin, which send signals to the brain to interpret.

It's this last bit, the part about the brain interpreting signals that we'll be ignoring today. Instead, I'll be talking about the physical impact of sound.

Remember the opening scene in the first Back to the Future movie when the heavily overdriven speaker throws Marty and his guitar into a bookshelf on the other side of the room? Even though it has all the elements- the huge speaker to get the energy waves started, the air between Marty and the speaker, and Marty's body to absorb the impact, he wouldn't actually have been thrown through the air in *quote* real-life. This speaker, big as it was, couldn't have exerted enough directional force. If he were to have lain on the speaker, however, he would have been in a world of pain and wouldn't have looked nearly as cool as he did when he took off his sunglasses.

The difference between him standing in front of the speaker and laying on it has to do not only with his degree of cool, but with the stuff between his body and the initial sound source. This stuff is called the medium. The metal of the speaker is considerably better at transferring mechanical energy than air. Solids are really good at this, air not so much, which, sorry to tell you, means that 'brown note,' ya know, the idea that you can make people crap themselves if you slam their bodies with extremely low bass frequencies, is just an urban myth. *(To all you terrorists out there, it's better to bomb around the clock, drop a nuke, cause sonic booms, or somehow set off a volcano or an earthquake. The ground and buildings are much more efficient media for getting mechanical waves into people's intestines.)*

Sound energy is a series of bumps. Since this is actual stuff, we have to consider the influence it has on the forces acting upon it. First thing is speed. In warm, dry air, sound bumps can do a mile every five seconds. That's going from Berlin to New York in about 5 hours, which I guess doesn't sound all that impressive. Airliners take about the same amount of time. Change the medium and that speed skyrockets. If the speed of sound can do Berlin to New York in 5 hours in the air, it takes about an hour and a half in water. And if it were to travel that same distance along a steel rod, it would take a mere 18 minutes. Then it starts to look a little more remarkable. Oh, and you can raise those speeds even more the hotter and more humid it gets.

Not only does the medium change the speed of sound energy, it also changes how powerful it can be. The unbelievably loud explosions of Krakatoa in 1883, which were heard up to 3,000 miles away, registered barometric pressure readings for five days, and are considered the loudest sound ever heard by humans, exerted less than half the pressure on the surrounding air than the weight of the atmosphere exerts on you as you listen to this. But, traveling through the sea and inner Earth, these sound waves circled Earth seven times, created tsunamis and all but destroyed the island of Krakatoa. Much the same, that fleet of dump trucks that comes down your street Saturday mornings at 6, rattling your windows and spooking your dog, isn't so much loud as it is transferring sound energy into the street, under your house and shaking everything right up to your bedroom walls, which then vibrate like so many massive speakers all around you. That's my Saturday morning experience anyway.

On to another visual illustration. It's this strange, pointless, and amazing video I found on YouTube of some kind of French billiards plus domino competition. A French dude strikes a cue ball, which hits this huge row of dominoes. As the dominoes fall, they bump into pool balls that roll into the corner pockets. Its ordered chaos and the line of dominoes keeps going until the last one in the line bumps a ball that then travels across a cue stick to another table where pretty much the same thing happens, then another ball goes to another table across another cue stick, and so on. Like 4 times. They just didn't know when enough was enough. Check out the link to the video on the transcript notes at Soundinthemachine.org (<http://www.youtube.com/watch?v=-Bgc67rf26I>).

Anyway, I like this because it demonstrates several important properties of sound, however imperfect the analogy. The first is that something has to get the whole thing started. And that means movement. In this case, it's the initial cue ball strike. In your daily life, something like throwing a brick at your neighbor's window or your dog's tail knocking a cup full of Kool-Aid off the coffee table gets things going.

The next thing is that there has to be something for that moving thing to bump into. If there were no other balls on our French-guy pool table, the cue ball would eventually run out of energy and stop. And, if there is no window for the brick to smash through or no Persian rug for the cup full of Kool-Aid to strike, both the brick and the cup will eventually run out of energy and stop.

So if there is nothing to bump into, there is no way anything is going to make a sound. If you're a geek, you've heard or, God forbid, made those complaints about the space shots of ships in *Star Wars* and how *they how they wouldn't make any sound in space*. But you're right- there's nothing to hear in outer space. The atoms floating around in empty space are too far apart. In a cubic centimeter of outer space there's only a couple of atoms. Contrast that with 10 followed by 19 zeros worth of molecules per cubic centimeter in our own atmosphere. In other words, there's not enough stuff in outer space to bump into—it's spread out all over the universe. So whatever would be making a lot of sound in any given atmosphere is dead silent.

On Earth, we've got tons of stuff packed together very tightly in the forms of water, air, trees, iPods, toupees, and dirt. Since the atoms in this stuff are so close together, whatever bumps into one atom, has the potential to transfer that energy into all of them.

Anyway, let's wrap up the Frenchy domino / pool trick analogy: we've got the cue stick getting everything started and the other stuff on the table all bumping into everything else and transferring energy and all that. After the balls are bumped, they land in a pocket, out of energy. There they'll sit until something gets them moving again. Same thing for the dominoes. Once they fall over, they sit until someone sets them up. It's pretty much the same thing for atoms that a sound wave has traveled over. After that initial bump, they jiggle around a bit, bump into the next atom, swing back a time or two and then just sit until some other force acts on them.

If nothing ever moved, there would be nothing to hear. Something moves and, by moving, it bumps something else, which then bumps something else and over and over again all the way up to the point where it reaches our bodies and our ear drums. Take a look at an exposed speaker. It moves but doesn't go anywhere. You'll see the surface of the speaker vibrating. Put your hand on it lightly to feel it. You can even let the hairs of your arm or nose, whichever are longer, dangle close to the surface. Nothing mystical is going on here. The speaker is just moving the molecules around it, whether they be air, your eardrums, or your nose hair. And it's doing this in all directions at over 1,100 feet per second.

What you are, and if you have ear drums, a nervous system and / or a brain determines what sensation you make out of those bumps. As humans, the atoms in that soup we call air, bump themselves into our skin and all the way up to our heads and into our ear canals where they bump into our ear drums. Then our brains interpret those bumps, hopefully as sound, not as an impending bowel movement.