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# Material witness: Sonic sense

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In ancient China, one of the most acoustically sensitive of world cultures, materials such as metal, wood and stone were classified by what they sounded like. The Chinese recognized that metal creates a very different sound from wood, just as the timbres of the brass and woodwind sections in today's orchestras fulfil very specific roles in painting images with sound.

But the acoustic fingerprints of materials remain underexplored. It is straightforward to measure the acoustic signals produced by, say, striking an object; but how this translates into a perception of timbre and then into an interpretation of the source is poorly understood. A listener's ability to distinguish the same pitch played on a trumpet and a clarinet obviously has something to do with both the harmonic content of the sound and its time variation. Yet our acoustic 'material sense' seems to be considerably more fine-tuned than that.

For instance, people have been shown to estimate accurately the elasticity of bouncing balls merely by hearing the sound of a single bounce. Some sounds with extremely complex time–frequency signals are experienced as single, clearly identifiable events, such as the smashing of glass. There seem to be particular acoustic signatures of 'glass-ness' and 'wood-ness' that create a perceptual link between very different sounds.

At the same time, our auditory sense of material can be fooled by context. Movie makers rely on this, which is why we wince at the sound of a cabbage being split in half when in a movie it accompanies an image of bones breaking. It's an example of so-called Foley sound, named after the 1950s pioneer of film sound Jack Foley, in which sounds made artificially by simple mechanical means 'stand in' for those associated with images in the film. Footsteps, rustling, jangling keys and creaking doors are reproduced live in a studio by 'Foley artists' as they watch the footage on a screen.

Clearly, the sound of jangling keys can be made by metal objects that are not real keys, but not by plastic ones. What are the limits of this mimicry? Bruno Giordano and Stephen McAdams have recently tried to map out the boundaries of our acoustic identification of materials by measuring the ability of a group of listeners to recognize sheets of plastic (plexiglass), steel, glass and wood from the sound when sheets of different sizes are struck (*J. Acoust. Soc. Am.* **119**, 1171–1181; 2006). Steel and glass could readily be distinguished from wood and plastic, but it was harder to differentiate within each pair.

Giordano and McAdams suggest that our recognition is based not so much on pure acoustic differences but on environmental 'training': for example, we tend to hear impacts

on smaller objects of glass (such as tumblers) than of metal (pots and pans), and for thicker objects of wood than of plastic. This learning generally serves us well, but it means we can be fooled by sound when the material sources come in unfamiliar shapes and sizes.