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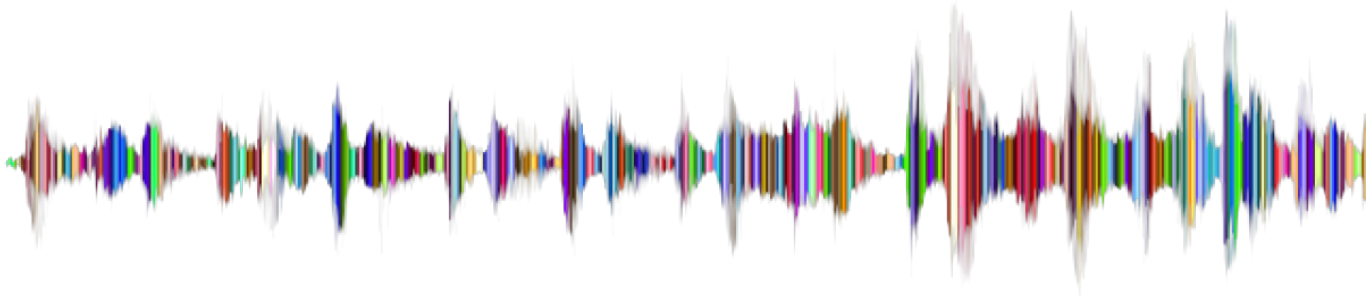

Your stapes is 3mm long and weighs 3 thousandths of a gram. It's the smallest bone in your body, yet plays a very big part in helping you to hear.

Vincent van Gogh once said that "great things are done by a series of small things brought together". He wasn't referring to the 3 tiny bones in your middle ear, but it's true that together they do achieve great things. Here's what you need to know about these little wonders.

Small but perfectly formed

The 3 bones are called the malleus, incus and stapes and they sit in your middle ear (the part between the eardrum and the cochlea). They are indeed small, measuring 8mm, 5mm and 3mm respectively, but they are beautifully shaped to resemble 19th century tools: the malleus looking like a hammer, the incus an anvil and the stapes a stirrup.

Having 3 small bones rather than 1 bigger bone is thought to afford protection: the bones move in response to noise, and a single bone might buckle if a sound were too intense, whereas a 3-boned chain can bend.

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Small but very important

The small things make a big difference. Dr Saurabh Varshney from the Himalayan Institute of Medical Sciences explains that severe hearing loss results when the bones are diseased or damaged, and that complete loss of their function results in a 60 decibel hearing loss (that's about the same volume as normal human speech; sounds in

excess of 120 decibels cause pain).

Frequent middle ear infections can erode the bones [5]; in a cholesteatoma [6], skin cells grow over the bones, damaging them; in otosclerosis [7], the bones knit together into a fixed mass. Thankfully, skilled surgeons can perform surgery [8] to repair or replace damaged bones (using tweezers to remove the plastic bones from the children's 'Operation' game doesn't come close to this level of intricacy).

How exactly do they work?

Sound is produced by vibrations: when you speak, the vibration of your vocal cords moves the surrounding air molecules rather as balls move on a billiard table.

The nerves that sense this sound in the listener's ear are within the fluid-filled cochlea of the inner ear, and that's where the problem arises. If you've ever swum underwater, you'll know that it's difficult to hear people speaking on the poolside, because most sound waves are reflected when they hit water. In a similar fashion, vibrating air caused by a speaker's voice would mostly be reflected by the fluid-filled inner ear of the listener.

This is where the bones of the middle ear come into their own. The incoming air molecules knock onto the listener's eardrum, 'wiggling' the 3 tiny bones. Working as a set of levers, the 3 bones *amplify* the sound 18 times, so that the final bone in the chain (the stapes) pushes quite forcefully onto the cochlear fluid, making a sufficient wave to be detected by the nerves. As a result, tiny sounds (such as a pin drop) can be detected.

Thankfully, tiny muscles [9] are attached to the tiny bones, and they can pull tight in immediate response to a very loud sound, reducing the leverage of the bones, protecting your hearing. A sudden explosion can, however, still cause damage because the reflex contraction of the muscles is not quick enough. It's up to you to look after your hearing [10].

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Links
[1] http://www.readersdigest.co.uk/health/health-centre/all-you-need-know-about-tiny-bones-your-ear [2] https://www.helencowan.co.uk/../tags/bones [3] https://www.helencowan.co.uk/../tags/brain [4] https://www.helencowan.co.uk/../tags/wonder [5] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3266081/ [6] http://www.nhs.uk/conditions/cholesteatoma/Pages/Introduction.aspx [7] http://american-hearing.org/disorders/otosclerosis/ [8] http://www.mauricehawthorne.co.uk/index.php/procedures-operations/ossiculoplasty/ [9] http://www.dizziness-and-balance.com/anatomy/ear/ema.html [10] https://www.actiononhearingloss.org.uk/your-hearing/look-after-your-hearing.aspx