Believing your ears

Listening employs our ears and brain in a complex process of sensing, processing and learning from sounds. We learn from each listening experience, tuning our ears and brain for the next sound, the next time we listen.[1] Our ears signal from a range of sensory cells, feeding our brains through numerous neural pathways, some for tone, others for timing, operating at different intensities via different routes and at different speeds.[2] Processing in the brain is sophisticated, adaptable and plastic. We are only now discovering some of the processes and pathways that our brains tap and process in flexible, innovative ways, always changing and learning. How, then, to design speakers to bring out the best in our listening?

Respecting our ears and brains is a good start. There is a growing body of evidence that our ears tell things us that our present-day measuring instruments cannot, and it is important to understand why. Fundamentally, our brains and ears are not passive measuring devices with fixed topology and circuitry. Rather, they adapt and change according to their use, building new neural pathways to accommodate new stimuli while culling disused pathways, including little-used auditory processes.[3] We can, and do, train our ears and brains to listen every day, in the city, in the country, in the concert hall and in our homes.

This is a boon for our listening and a complicated challenge for acoustic research. For instance, when Blauert and Laws set out to measure listeners' perception of distortions from time delayed signals, they found that their subjects so rapidly learnt how to detect the distorted test signal that their original experimental design had to be changed. To improve their method, they deliberately trained their listeners over 15 sessions and found that all of them achieved sustained improvements in their measured ability to detect distorted test signals.[4]

In fact, the flexibility of ear and brain so great that we can build new neural pathways to compensate even for extensive damage to our ears. Oliver Sacks cites the case of an avid concertgoer who, after suddenly losing the hearing in one ear, found that his brain eventually created psuedo-stereo perception via his other ear.[5] And our sensory abilities tax the speed and precision of our best measuring equipment. Endeavouring to determine the limits of human ability to detect the time-smearing of audio signals, Kunchur found that his test-subjects could reliably detect significantly smaller time differences than previously measured. Commenting on the limits of historical testing, Kunchur observed that 'the bottleneck then arises from the limitations of the [*measuring*] apparatus rather than the ear.'[6]

Our ears tell us that, given a choice, they tend to prefer sensitive point-sources, like full-range drivers. They tell us that they like wide-bandwidth signal sources and amplifiers, and simple

---

[1] Doidge, N., *The Brain That Changes Itself*, Viking Press, 2007, p. 15.

[2] Kunchur, M., 'Audibility of temporal smearing and time misalignment of acoustic signals', *Technical Acoustics*, 2007, p.1.

[3] Doidge op. cit., pp. 57-59. Of particular note are clinically proven therapeutic listening programs to assist children with learning difficulties and disabilities. These therapies 're-wire' auditory and other neural pathways to achieve their results.

[4] Blauert, J. and Laws, P., 'Group delay distortions in electroacoustical systems', *Acoustical Society of America,* 63(5), May 1978, pp. 1478-1483.

[5] Sacks, O., *Musicophilia*, 2008, pp. 178-183.

[6] Kuncher op. cit., pp. 9 and 1.

crossovers. And they tell us that they perceive diffracted sounds from the edges of speaker enclosure as distortion, frequently called ‘boxy-ness’.[7]

Measurement and analysis are not redundant: they help us define important, basic parameters that set the broad boundaries of good listening. They are the basis of thoughtful engineering but they are not yet the *sine qua non* of the listening experience: pride of place is reserved for you and your perceptions, your experiences, your needs for listening and learning.

K.M.Bond. BA BE

---

[7] A common though misleading term, encompassing several types of audible signal error and distortion. A more rigorous account of the diffraction distortions that can arise from enclosures with distinct edges or surface discontinuities is in Wright, J., ‘Fundamentals of Diffraction’, *Journal of the Audio Engineering Society*, Vol. 45, No. 5, May 1997, especially pages 354 and 355.