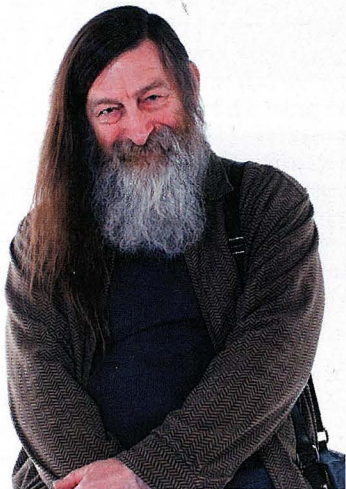


# Mics and ears

**Popular myth has it that a microphone is just like an ear. JOHN WATKINSON argues that particular belief is a recipe for failure and that proper microphone technique stems from the fact that ears and microphones are completely different.**



Everyone has heard recordings or broadcasts in which the sound has an unpleasant echoing quality and what should be background noises are excessively prominent. In practically every case whoever made the recording was exposed to an original sound and went ahead expecting to capture it, but somehow didn't. The unfortunate thing is that we then get to hear the failure. I would draw an analogy with some photographers who insist on showing us every picture, including the ones that are rubbish. They either don't know they are rubbish, or they don't realise that in order to make progress one has to set one's own standards and reject whatever doesn't meet them. They can't see how

much better the impression would be if we were shown only the best and the poor ones served as the impetus to do better.

And so it is with microphone technique. If only the disparity between the result and the original sound served to trigger an investigation of what went wrong and what to do about it... But before a problem can be solved it has to be understood, and if politicians don't know that, it's not fair to pick on anyone else, and much more relevant to consider what the problem is.

These days I find that better results are obtained sooner by cutting through the myths and the nonsense. We are told practically from childhood that the eye is like a camera and the ear is like a microphone, despite overwhelming evidence to the contrary. While there is some superficial similarity between the eardrum and the diaphragm of a microphone, in that both move in response to sound, and some sort of signal is generated, that's about as far as it goes.

The actual transducers form only a small and generally questionable part of the Human Auditory System (HAS). Small bones are required to move at audio frequencies in order to slosh fluid down tubes. This unlikely arrangement is eloquent testimony that the concept of Intelligent Design is risible.

The depressing state of modern motor vehicles means that mediocre chassis with penny pinching suspension design and dubious weight distribution can be ameliorated by using anti-lock brakes, traction control and automatic stability control software. In a sense the HAS is like that, because the shortcomings of the ears are made up for by some quite impressive software that evolved between them. And this software didn't evolve for entertainment purposes, but as a survival mechanism.

It is important to realise that the HAS does not operate in isolation, but in concert with the other senses. Together the senses are trying to create a model of our surroundings that we call reality. Consciousness may be no more than reactions to that reality which tend to be self-preserving.

Part of that modelling of our surroundings consists of attempting to identify objects that are distinct from the background. To this day the HAS tells us where and how big an object is before we learn what it sounds like. If we can see the object, then the visual and auditory systems may agree that both stimuli are due to the same object. Equally, if we can't see an object, but we can hear it, it will occur to the senses that it may be behind us.

During the time when the sound source is being located, the HAS works in the time domain and is acutely sensitive to the actual waveform. The waveform at one ear will be correlated with the waveform from the other ear to measure the inter-aural delay that is a function of direction. Not only that, but if we feel curious about the sound from that direction, the HAS is capable of inserting the same delay in series with the advanced ear, so that the signals from both ears can be added and will maximally augment, whereas sounds from other directions will not. This is known as attentional selectivity, also called the cocktail-party effect. A related phenomenon is found in certain individuals who appear to be completely unable to hear sounds that fail to correlate with their dogma. This is the political-party effect.

The cleverest trick the HAS employs is that in reverberant surroundings, we locate the source from the first arriving sound. Later reflections from different directions do not change that perceived direction, but instead the reflected sound energy simply

augments the level we perceive. This is known as the Haas effect after Helmut Haas.

The main reason for the greater realism obtained when listening on headphones to recordings made with a dummy head is that the listener can still employ attentional selectivity because the spatial information in the original sound is kept intact. The same is true of stereophonic recordings made to stringent criteria and heard on loudspeakers that also preserve the spatial information.

Typically the original sound we hear sounds completely different to the reproduced version. This is usually because the criteria for spatial accuracy that allow the beneficial functions of the HAS to operate on the reproduced version are simply not met. Wanted sound, reflections and noises are then jumbled up spatially and can never be separated again.

Today's microphones can't yet see and are unable to implement attentional selectivity or the Haas effect and as a result are completely naïve. They don't know what they are supposed to be interested in so, like Clouseau, they hear everything, including the reflections and noises off. The key to successful use of microphones is to realise that naivety and to start to listen as a microphone would.

For example if we are listening with our own ears in the vicinity of a flat wall or a plate glass window, attentional selectivity and the Haas effect together will make us less aware of the strong reflections from that hard surface. A microphone in that location would not fare so well as it can't reject the reflections as a sentient being can. A recording made there would be unsatisfactory as strong reflections combine with the original sound to form a comb filter.

Part of the problem today is that the demise of architecture has resulted in an excessive number of buildings and spaces having seriously impaired acoustics. The impossibility of using microphones in these failures is often academic as it is not even possible to have a face to face conversation.

A non-obvious way of eliminating reflections from a hard, flat surface is to put the microphone as close to the surface as possible. In that way the original sound and the reflections coincide. This is the principle of the pressure-zone microphone which is designed to work on flat surfaces.

It is essential visually to assess any location for features that a microphone won't like. By comparing the predictions made by a visual check with the actual results obtained, we can learn to see sound and to anticipate potential problems before they bite us. Probably the most important characteristic a microphone has is its directivity, as revealed by the published polar diagram. The polar diagram is a circular graph where the magnitude of the response is plotted as the distance from the origin with respect to the angle from which the sound arrives. The ideal directivity is often lost at extremes of the audible frequency range. The better the microphone, the wider the frequency range over which the directivity is maintained.

Microphone directivity is a double-edged sword. It is practically axiomatic that the more difficult the acoustic the more directional the microphone needs to be. But the more directional the microphone, the less ambience sensed and the drier the sound will be. The criterion has to be whether the off-axis sound is desirable or not. You can't get back intelligibility that has been lost, but you can fix dryness with artificial reverberation, so this would suggest erring on the directional side. This may explain the popularity of large-diaphragm microphones which tend to become more directional at high frequency.

The polar diagram of an omnidirectional microphone is a circle, indicating the same response from all directions. The microphone that hears everything is not going to be useful in any but the finest acoustics. Even then the omni characteristic typically fails badly at short wavelengths and there is a loss of HF in most directions. Wanted sound sources need to be placed where the HF survives.

Cardioid and fig-8 microphones have nulls in certain directions. In the cardioid the null is at the back, whereas in the 8 it is at the sides (and above and below). Microphones with nulls are most useful if the null is pointed at the unwanted sound. This offers typically better rejection than aiming a lobe at the wanted sound.

One difficulty with directional microphones is that time accuracy is sometimes lost in obtaining the necessary directivity. This seems to be most prevalent in cardioid microphones. Highly directional microphones such as shotguns and rifles tend to revert to a broader directivity at low frequencies and need filtering. ■

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