

Speech Acoustics Made Easy

Why do I need to know?

As a parent, carer, relative or professional working with a person with a cochlear implant, you will find that a basic understanding of speech sounds and their acoustic properties will help you to understand *why* your cochlear implant team professional may be recommending certain strategies and techniques and *how you* can help to get the best results with a cochlear implant. This is particularly important when a child is learning to listen for the first time.

It is useful to remember that only 40% of English speech sounds are readable on the lips. Today's hearing aid and cochlear implant technology enables recipients to hear all speech sounds across the frequency range. Combined with appropriate (re) habilitation support, hearing impaired children and adults are able to develop and use their listening abilities to communicate effectively with people around them.

For children, it is also important to remember that reading is an auditory activity: We learn to read by associating groups of speech sounds through their *auditory* properties – that is, the way they *sound*.

How are speech sounds described?

In acoustic terms, vowel sounds and consonant sounds are described by their *average pitch* (frequency, measured in Hertz – Hz) and their *average loudness* (intensity, measured in decibels – dB) at conversational speech levels. The term *formant* is used to refer to peaks of acoustic energy in speech sounds.

What are the important acoustic aspects of spoken English?

In English, vowel sounds are typically lower pitched than most consonant sounds. They are also perceived as louder and longer, so are generally easier to hear. However, most of the meaning in spoken English is carried by the higher frequency consonant sounds, therefore they add far more to the overall intelligibility of speech than vowel sounds.

To illustrate this point, look at the following sentence with the consonants removed, and then with the vowels removed:

“ e a a o e a “

“th ct st n th mt”

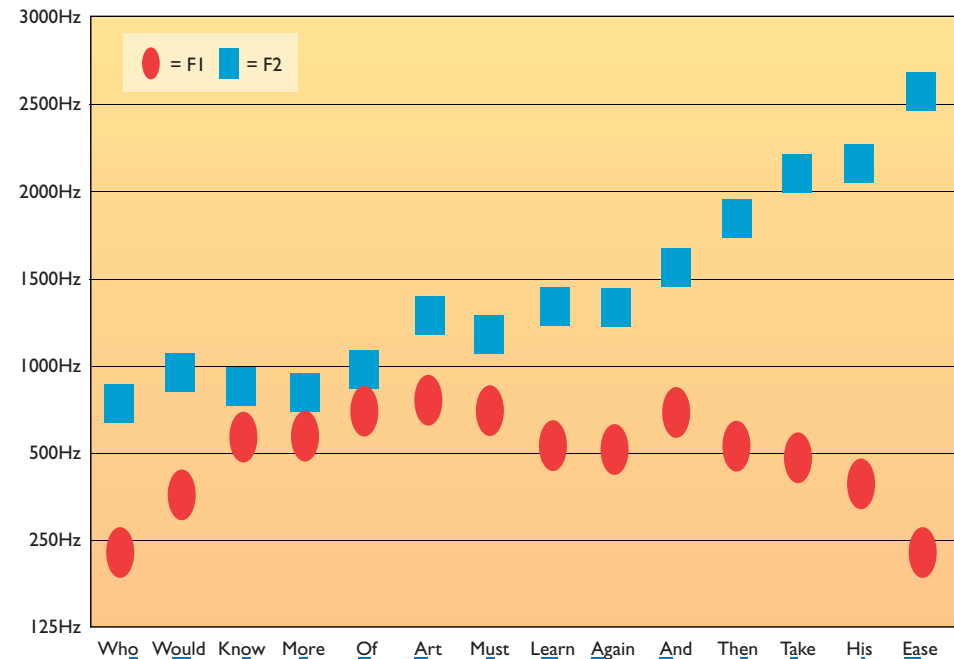
The sentence (“The cat sat on the mat”) is much easier to work out with the consonants in place.

What impact does this have on a person with a hearing impairment?

Because consonant sounds are spoken more softly than vowel sounds, they are often ‘drowned out’ by the vowel sounds. Any background noise serves to drown these soft sounds even further:

Remember in optimal listening conditions, cochlear implant users are able to perceive very quiet speech sounds, but once these sounds are in words and running speech, they become harder to hear.

English Vowel Sounds

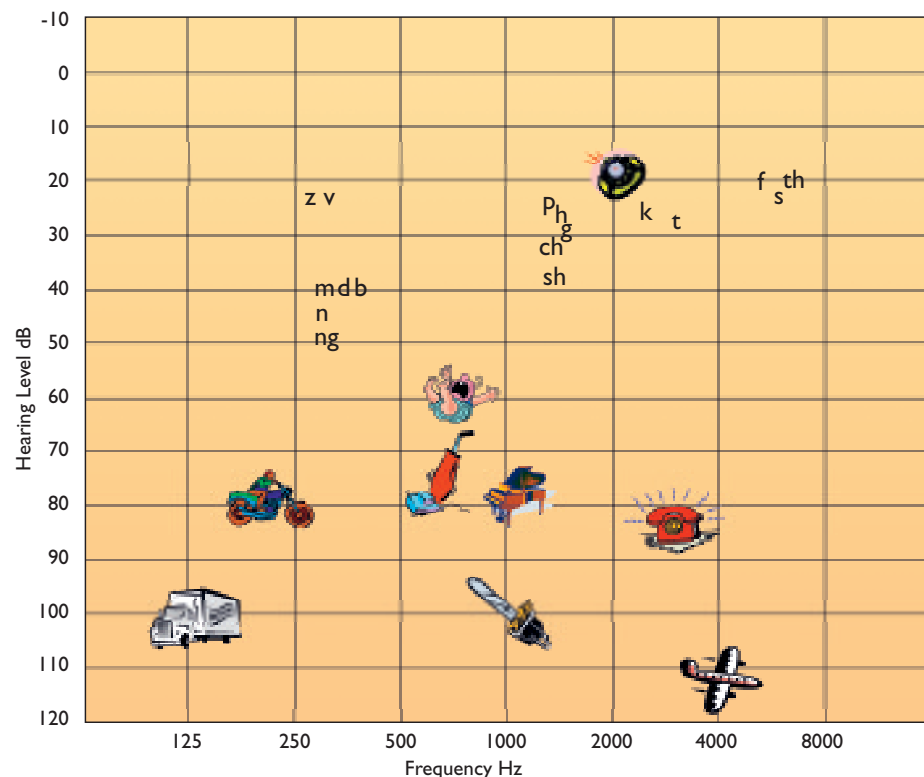


What does this graph mean?

This graph shows the average of the first two peaks of acoustic energy (formants) for each vowel in English. In order to be able to hear all of the vowels, a person only needs good aided hearing in the speech intensity range of 50 - 60dBa up to 1000Hz. In order to discriminate

between the vowels, that person needs to hear up to 3000Hz – and this helps us to discriminate between words that otherwise sound the same: e.g. bad, bed, bead, bid, bird.

English Consonant Sounds



What does this graph mean?

This graph shows the average frequency of some of the consonant sounds in British English, when spoken at conversational levels. It is worth remembering that most consonant sounds have complex peaks of acoustic energy, therefore this graph only represents the frequency at which each consonant is most audible. You can see that some sounds are low pitched and relatively loud such as the nasal sounds 'm, n and ng' (as in

sing), whereas others are high pitched and quiet, such as 'f, s and th' (as in thin). Compare these with the lower pitched, louder vowel sounds.

The graph also shows the average pitch and loudness of a range of environmental sounds. As most of these sounds are louder than conversational speech, it is important to try to minimise these background noises as much as possible.

How can we all help?

- **Use a normal conversational loudness levels**

Very loud speech can make vowel sounds louder drowning out the consonant sounds further. Loud speech can also lead to a distorted signal which the hearing impaired person finds even more difficult to understand. Finally, talking loudly often makes lip patterns more difficult to read.

- **To make sounds easier to hear, move closer to the microphone**

Position yourself close to the microphone on the hearing aid or speech processor. This is especially important with young children and can be easily achieved during comforting, play, reading books together and during mealtimes when sat at the table.

Remember: move closer rather than raising your voice.

- **Use FM systems in schools, colleges and during meetings**

This has the same effect as moving closer to the microphone.

- **Reduce background noise whenever possible**

Turn off the television or radio at home, use acoustic treatments* in schools and workplaces. Encourage 'good listening' for the whole class at school.

- **Use a sing-song voice with young children**

This makes speech more interesting and keeps the child's attention for longer.

- **Carry out daily checks of the device to ensure it is working optimally.**

Use monitor earphones to listen to the quality of the microphone. Perform a Ling Sound test with children*. Keep the processor clean and use a dry store overnight

- **Use short, meaningful phrases**

Try not to use single words in isolation. Single words do not give people with hearing impairment time to "tune in" and do not help children to learn the rules of language. Contextual and grammatical cues form a large part of speech understanding, even for people who hear normally.

* Your hearing specialist or member of your cochlear implant programme should be able to help you with this.