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Speech Acoustics

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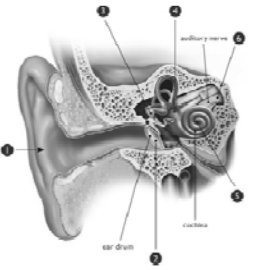
What is sound ?

- When an object vibrates it causes movement in the surrounding air particles.
- This movement is propagated through adjacent particles.
- It keeps going until they run out of energy.

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The Ear

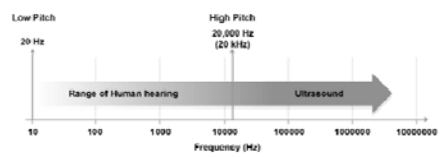


1. Outer ear → eardrum
2. The eardrum vibrates.
3. Oscicular Chain vibrates.
4. Fluid in the cochlea propagates the basalar membrane.
5. Hair cells vibrate and generate neural signals. Electrical Impulses → auditory nerve.
6. Auditory nerve → brain
7. Perception of SOUND

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Range of Human Hearing



www.bbc.co.uk/schools/gcse/size/science/aga/waves/soundandlightrev1.shtml

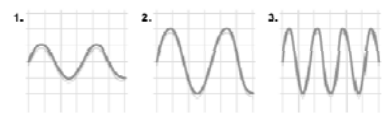
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Threshold of Hearing Weighting

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Sound Waveforms



www.bbc.co.uk/schools/gcse/size/science/aga/waves/soundandlightrev1.shtml

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The Audiogram



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Voicing frequency

- Also known as Fundamental Frequency or F_0
- It is the frequency of vocal fold vibration and correlates with vocal fold tension and subglottal air pressure
- When relaxed a person will have a natural fundamental voicing frequency.
- Male=85-155Hz, Female=165-255Hz, Child=250-650Hz
- F_0 will vary in tonal languages and when we use intonation and sing.

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Formants

- In speech the resonant frequencies of the vocal tract are called formants. They are seen as high intensity peaks in the speech spectrogram.
- Different speech sounds can have different numbers of characteristic formants and these are numbered in order of frequency (lowest first) from F_1 , F_2 , F_3 ...

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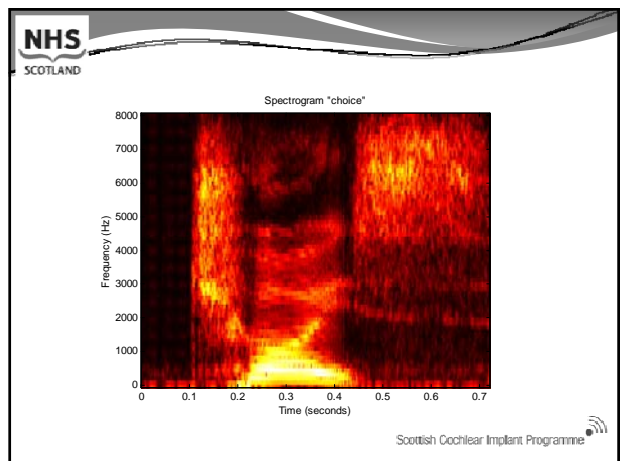
Vocal Resonators

Resonators:

1. pharynx
2. oral
3. nasal
4. larynx

<http://www.unit.ch/islfr/home/menuguid/resources/cours-e-et-fvres-en-igne/introduction.html>

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Speech Organs

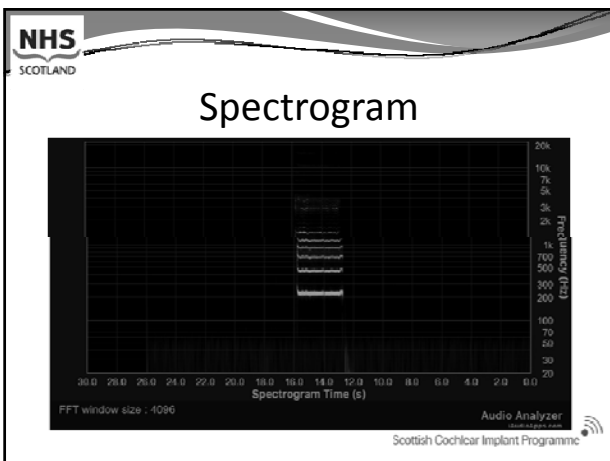
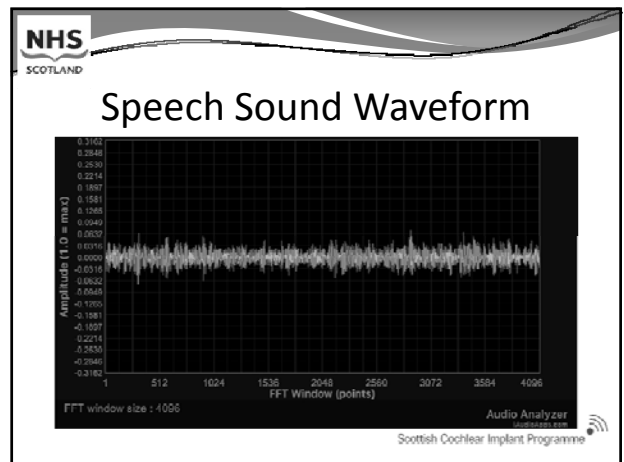
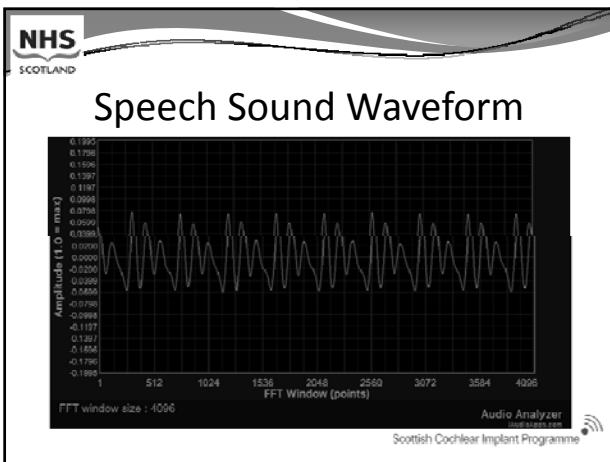
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Speech Signals

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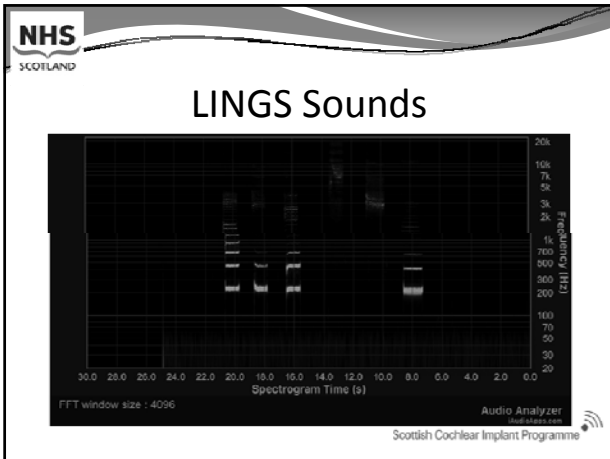


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LINGS Sounds

- Daily check
- Detection & Discrimination

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The Hearing Brain

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Hearing comes before speaking

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The Hearing Baby

- photo

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We speak the way we hear.

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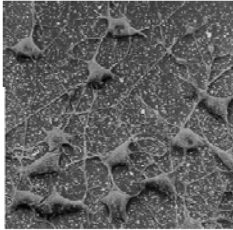
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When a baby is born all of the organs: the heart, lungs and kidneys are fully developed but smaller than an adults. All except one organ – the brain !

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100 billion neurons

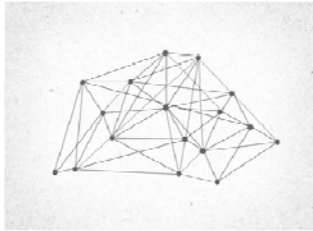


www.sciencemuseum.org.uk

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Each neuron has 10,000 connections (synapses)

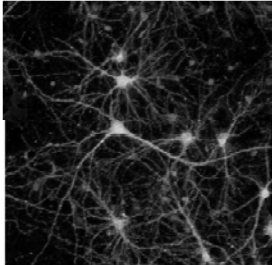


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Neural Networks – 1,000 trillion connections

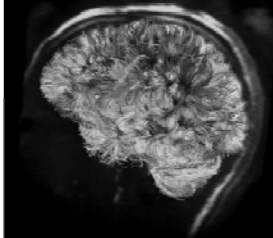


www.amusedblog.com

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The Developing Brain



www.eelanmedia.com/amazing-pictures-of-the-brain-at-work

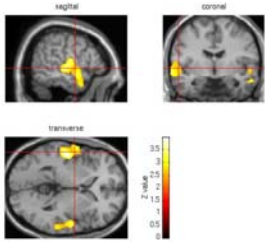
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Two Hemispheres

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SPECT – Narrative Speech



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Cortical Activation

- Auditory Speech vs Visual Speech
- Spoken Language vs Sign Language
- First Language vs Second Language

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Consequences of Profound Deafness

- Stops auditory cortex and auditory pathways from developing.
- Prevents language centres in brain from developing.
- Language centres in the brain develop through exposure, experience and practice –needs to happen within a critical time frame.

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Nature and Nurture

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Language cannot be acquired passively.

For language development to occur interaction has to take place.

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From the time of conception until about the third birthday is the most critical period of human development.

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Stimulation is crucial for a child's social, emotional, physical and cognitive development.

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Very young children learn ~ 90% of information they acquire incidentally.

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Parents and parenting influence this process.

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Using every opportunity to play, talk, sing, play music, read, tell stories.....

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Baby Beats

- photo

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What does it sound like ?

- How do adults describe the sound sensation at switch-on?
- What about children who have never heard before? What do they hear?
- Mathematical models are of limited benefit because hearing is a perception.

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Coding Strategies

Spectrogram "choice"

Frequency (Hz)
Time (seconds)

ACE Electrodegram "choice"

Electrode
Time (milliseconds)

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- Video Clip

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Is the Sound Sensation Meaningful ?

- For Adults and Older Children who have heard previously – Yes

Depending on the duration of deafness (previous hearing experience), it can take time to achieve their full potential (weeks to months).

It's a personal journey and everyone is different.

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What about children ?

- Congenitally deaf children have the potential to develop age appropriate spoken language - provided that they undergo CI at a young age, wear their cochlear implant processors all day / every day and are immersed in spoken language.

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Do cochlear implants 'work' equally well for everyone?


- All cochlear implant users have exactly the same audiogram
 - It is flat across the full frequency range
 - Hearing thresholds are equivalent to a mild hearing loss
 - Hearing does not deteriorate

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Factors Influencing Outcome


- Hearing history
- Age at time of implant
- Home environment
- Device use
- Communication approach
- Co-existing morbidity
- For adults –motivation.

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Outcomes in Children

- The earlier children are implanted, the better the spoken language outcome - provided that they wear the CI device all day / every day and are immersed in spoken language.
- Co-existing morbidity can impact on spoken language development and some conditions may not manifest or be diagnosed until the child is older.

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Acknowledgement

- Many thanks to Advanced Bionics, Cochlear Europe Ltd. and Med-El for pictures, photographs and diagrams.

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