Paediatric cochlear implants: challenges and future directions

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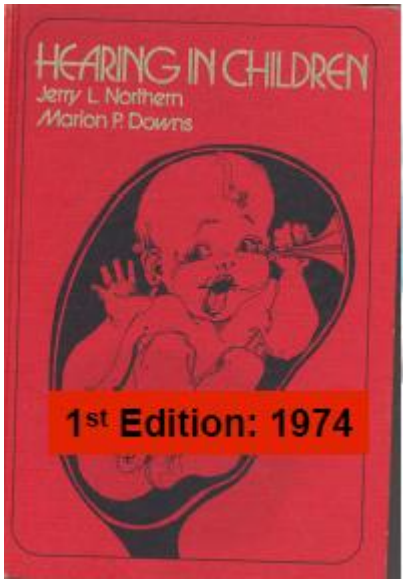
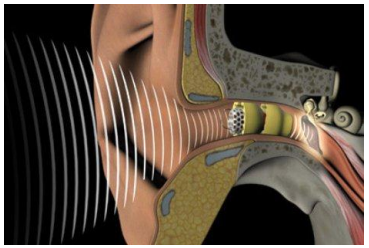
Current Developments and New Directions
In
Pediatric Audiology, Istambul 2011

The best of times ...

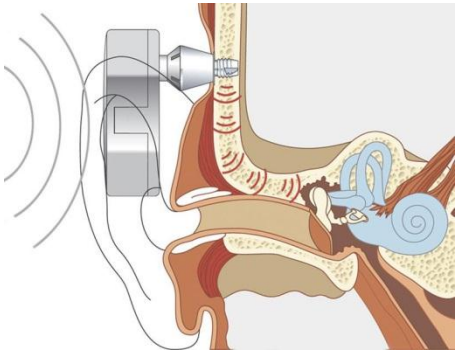
- Late identification
- Delayed diagnosis
- Poor amplification
- Education : low expectation
- No cochlear implants
- Public Health Policy

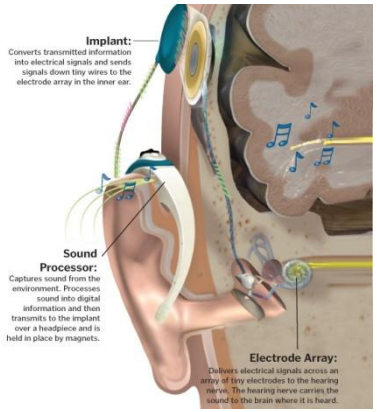


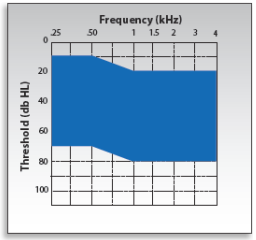
Prostheses

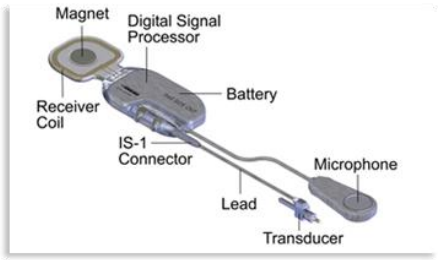


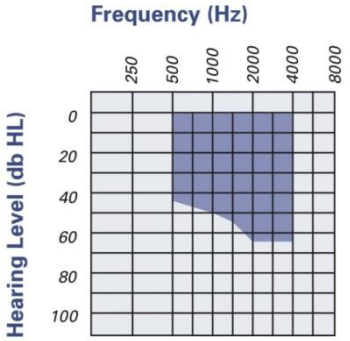
Prostheses - implantable

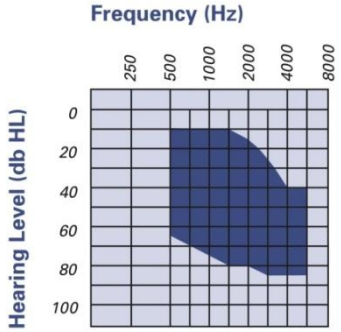








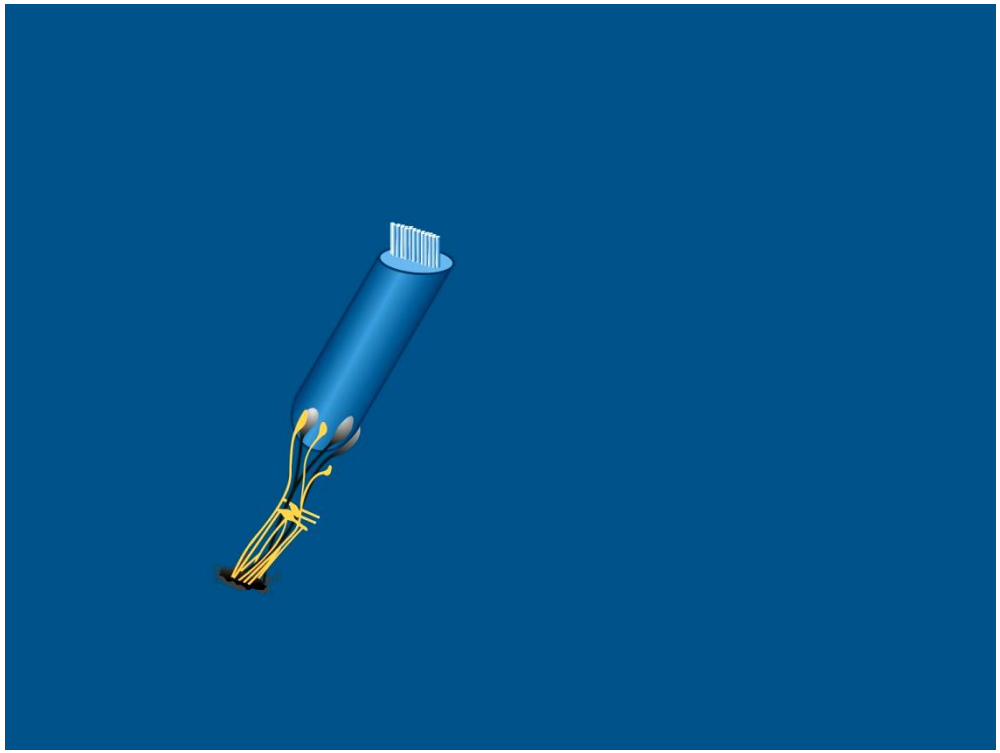


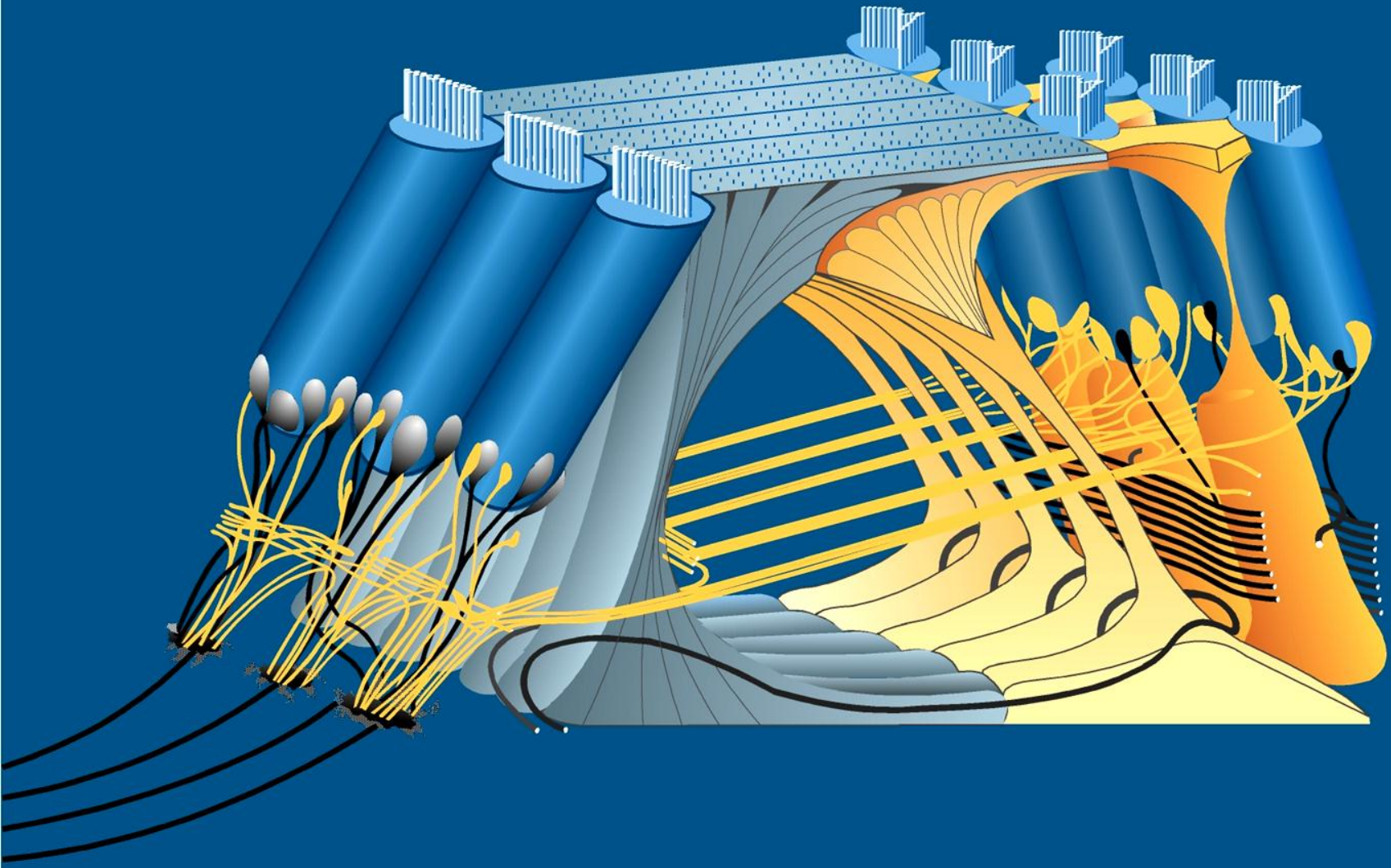


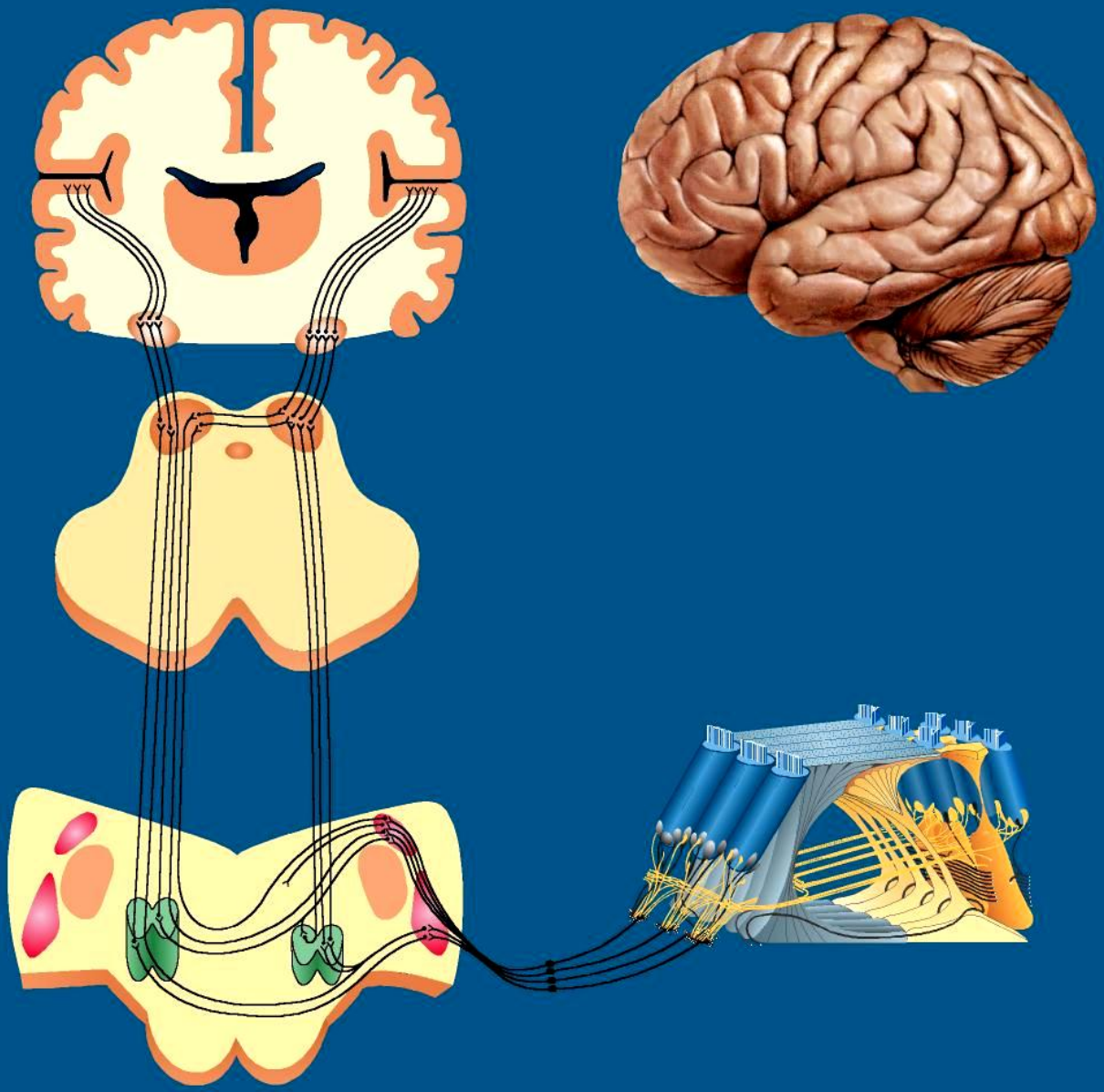
Overview

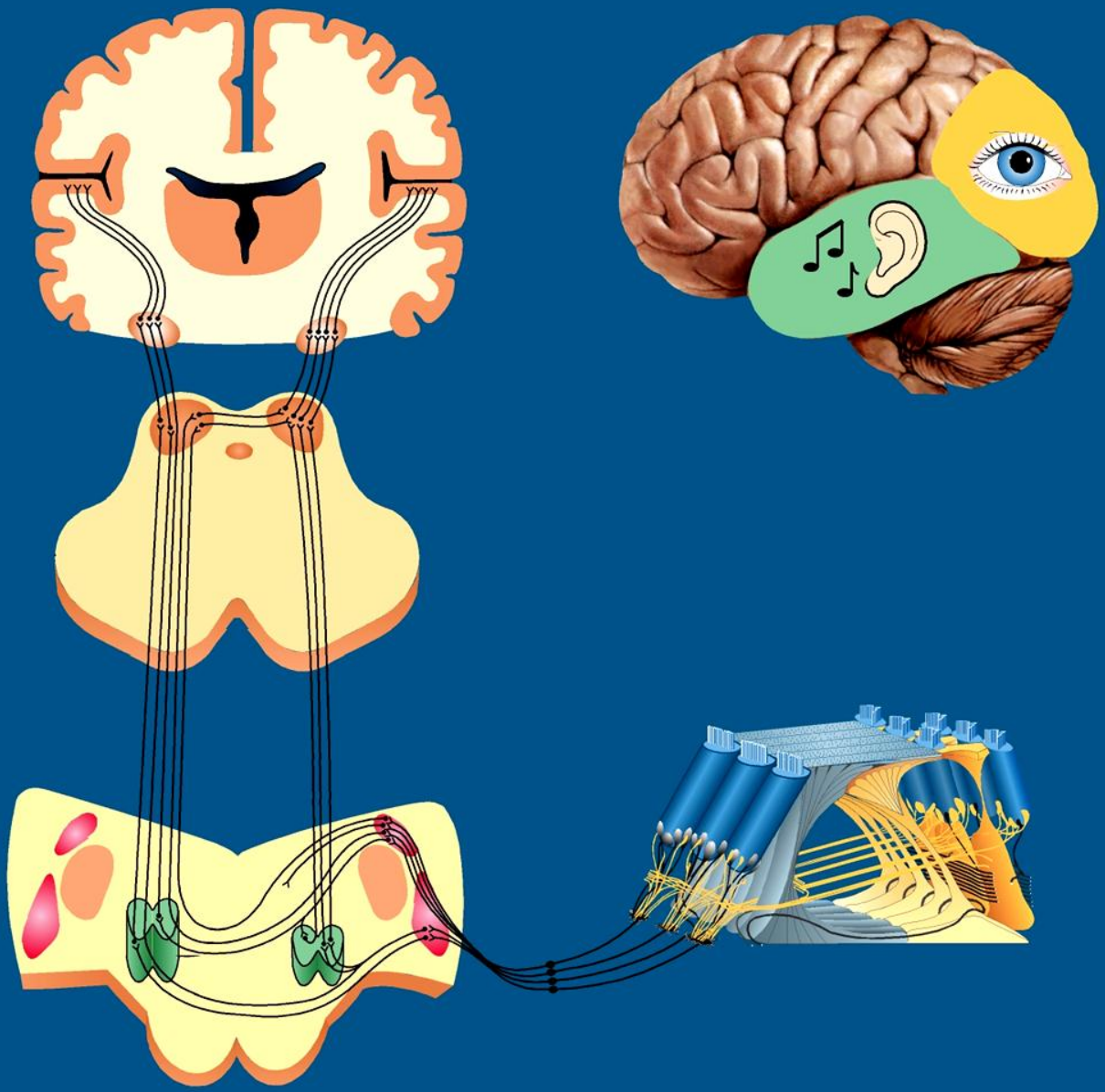
- Neurobiology of deafness
- Plasticity into Practice
- Early cochlear implantation
- Bilateral CI
- Medical and surgical aspects
- Electro-acoustic hearing / ABI etc
- Turkish Temple

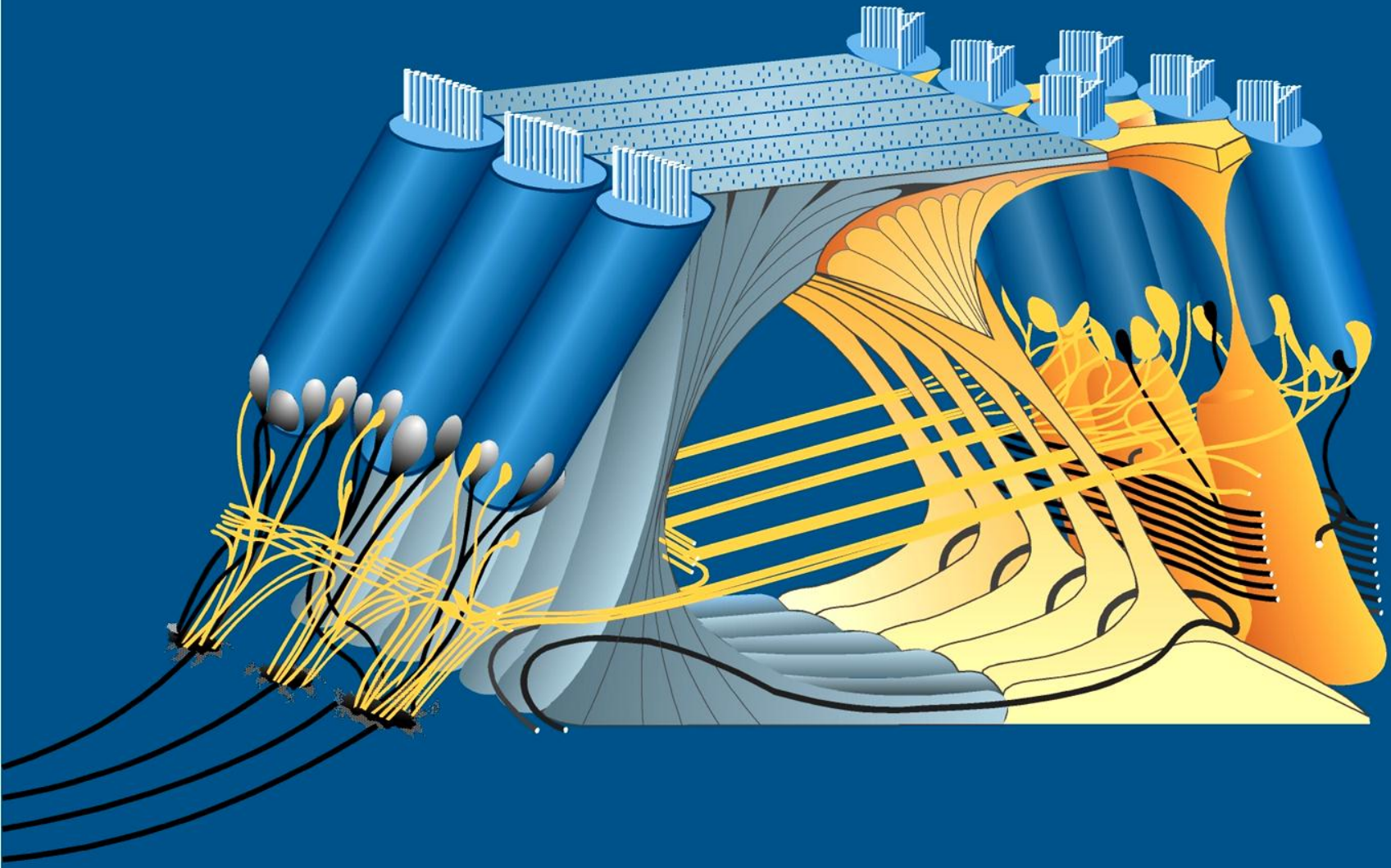
Human Auditory System

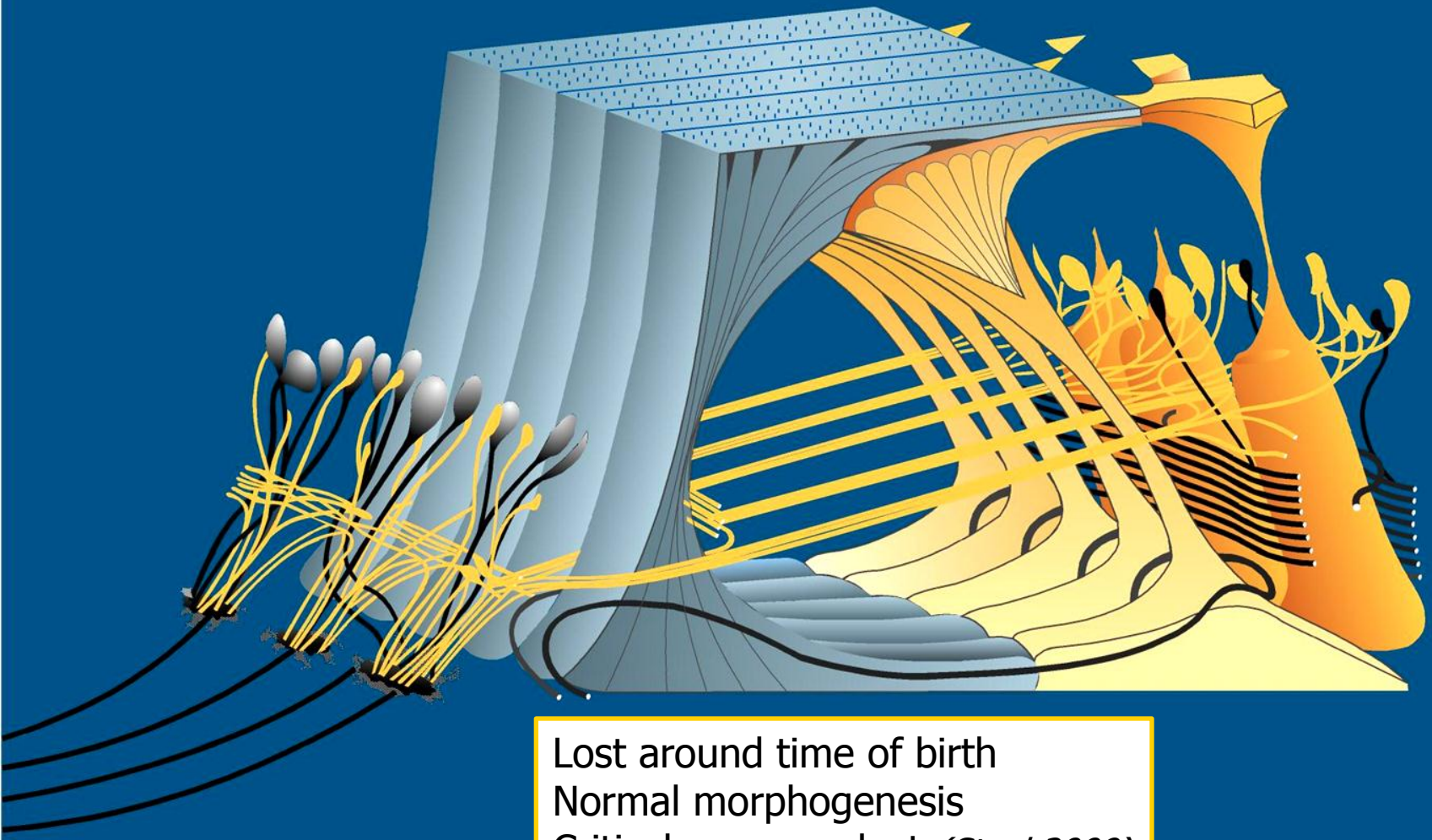




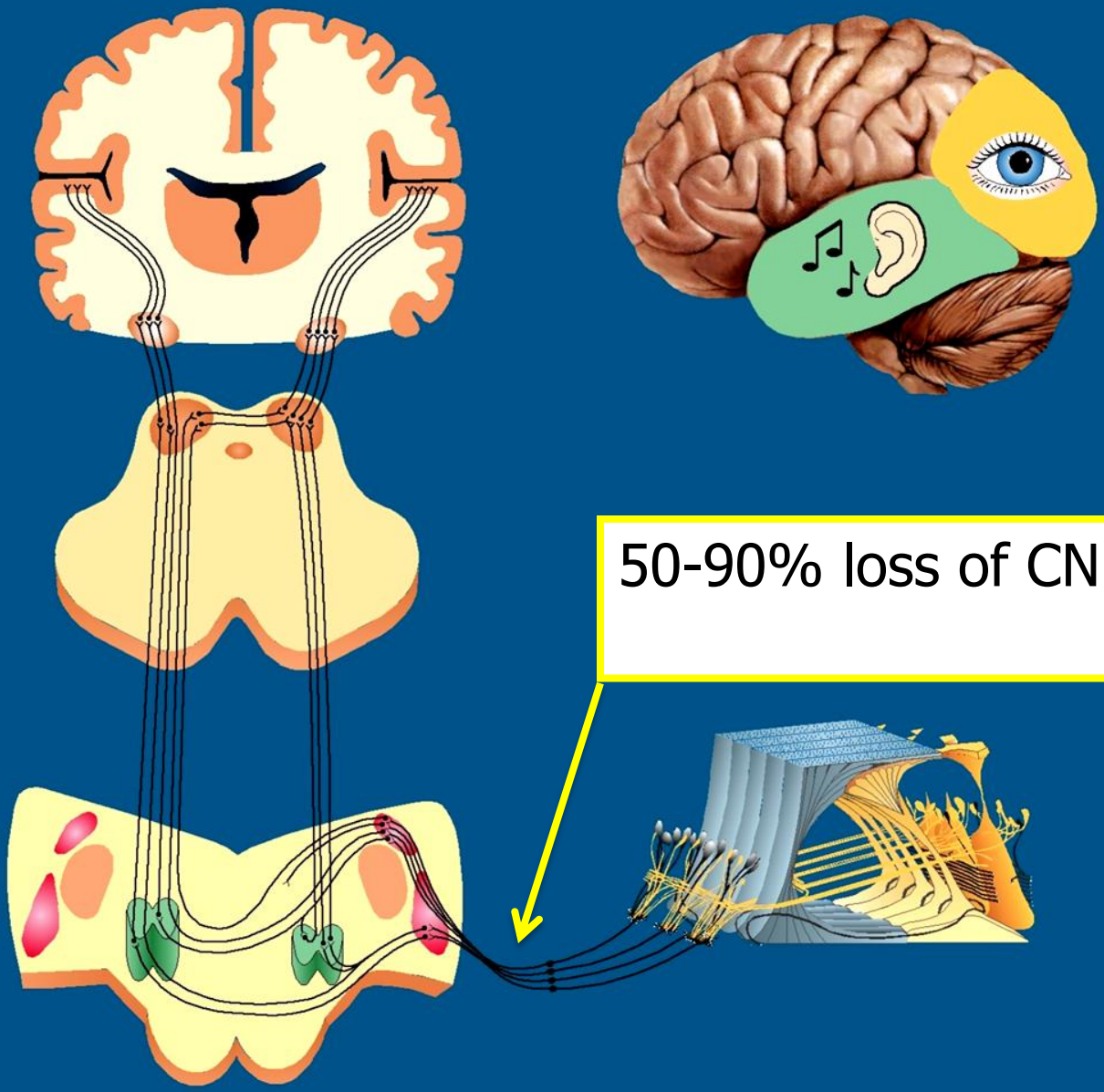




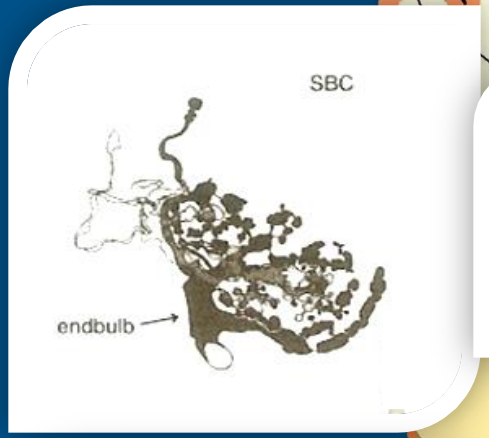


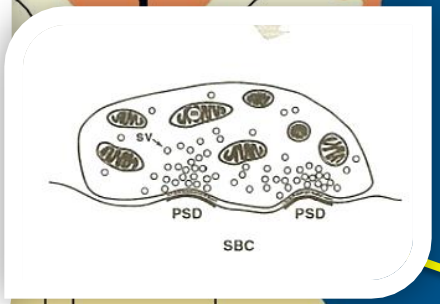


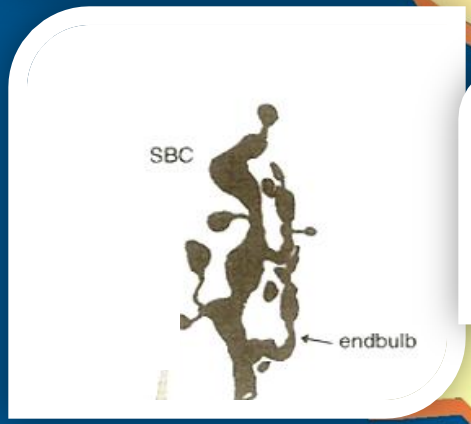
Lost around time of birth
Normal morphogenesis
Critical gene product *(Steel 2009)*

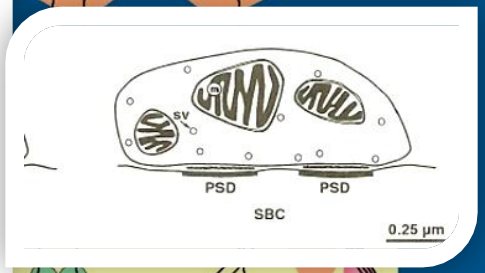


50-90% loss of CN neurones

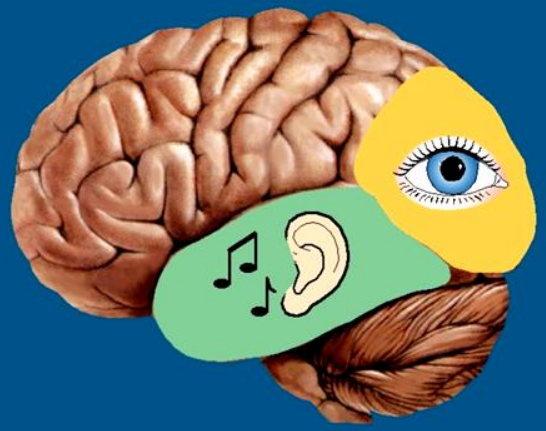




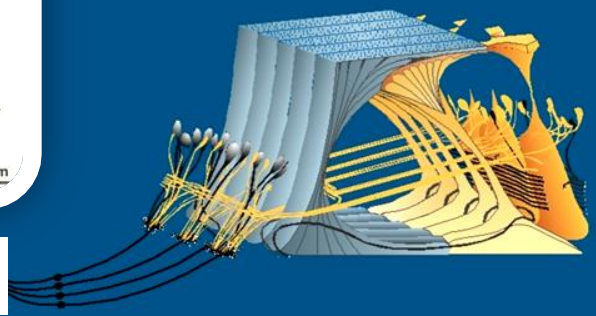


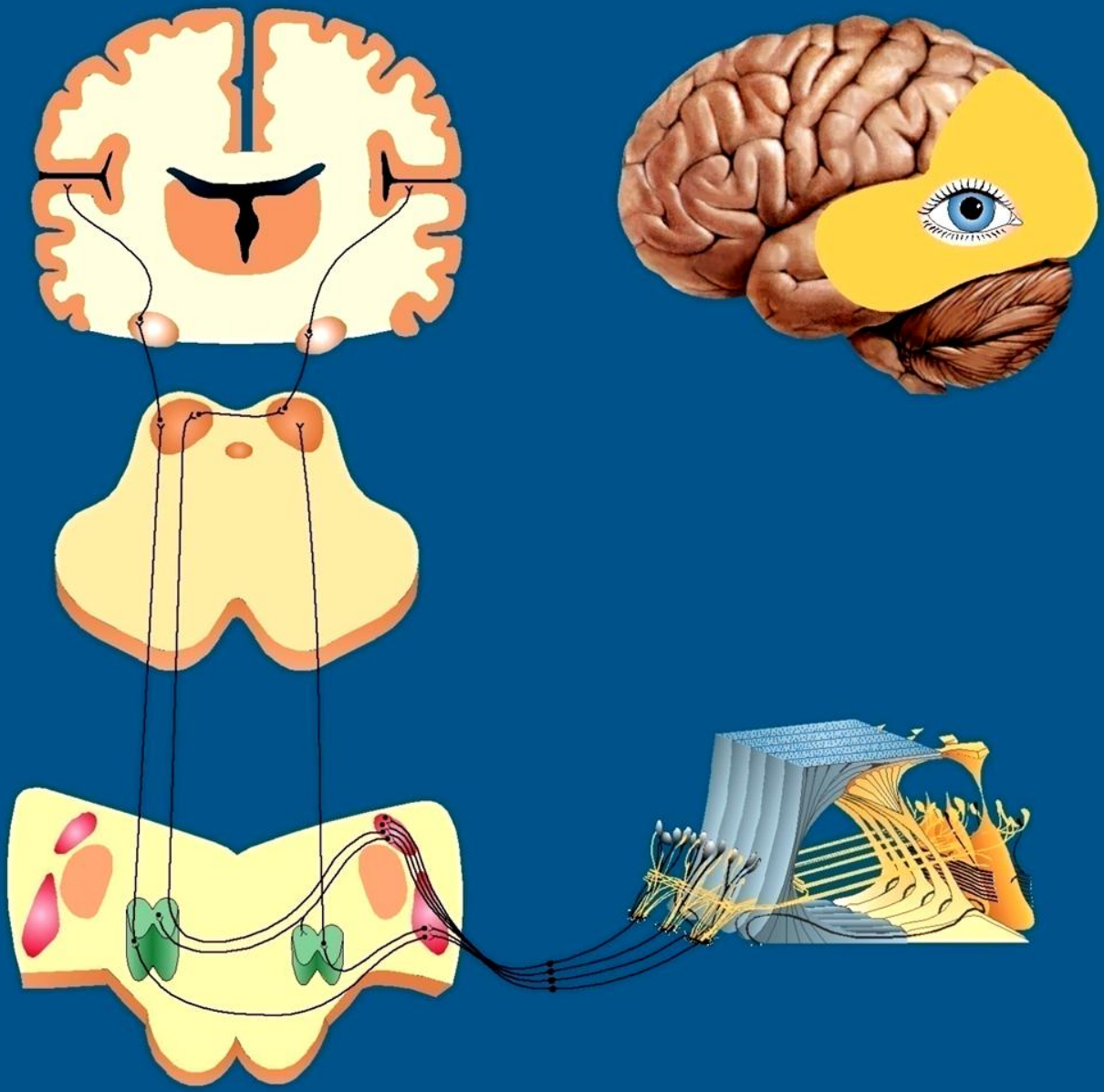


Ryugo et al 1997



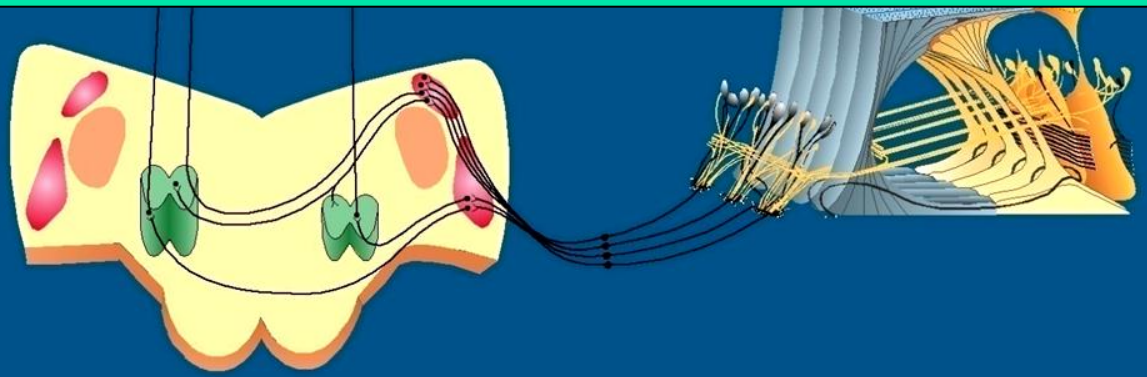
Quality and number of synapses
Hyperexcitability *(Eggermont 2008)*



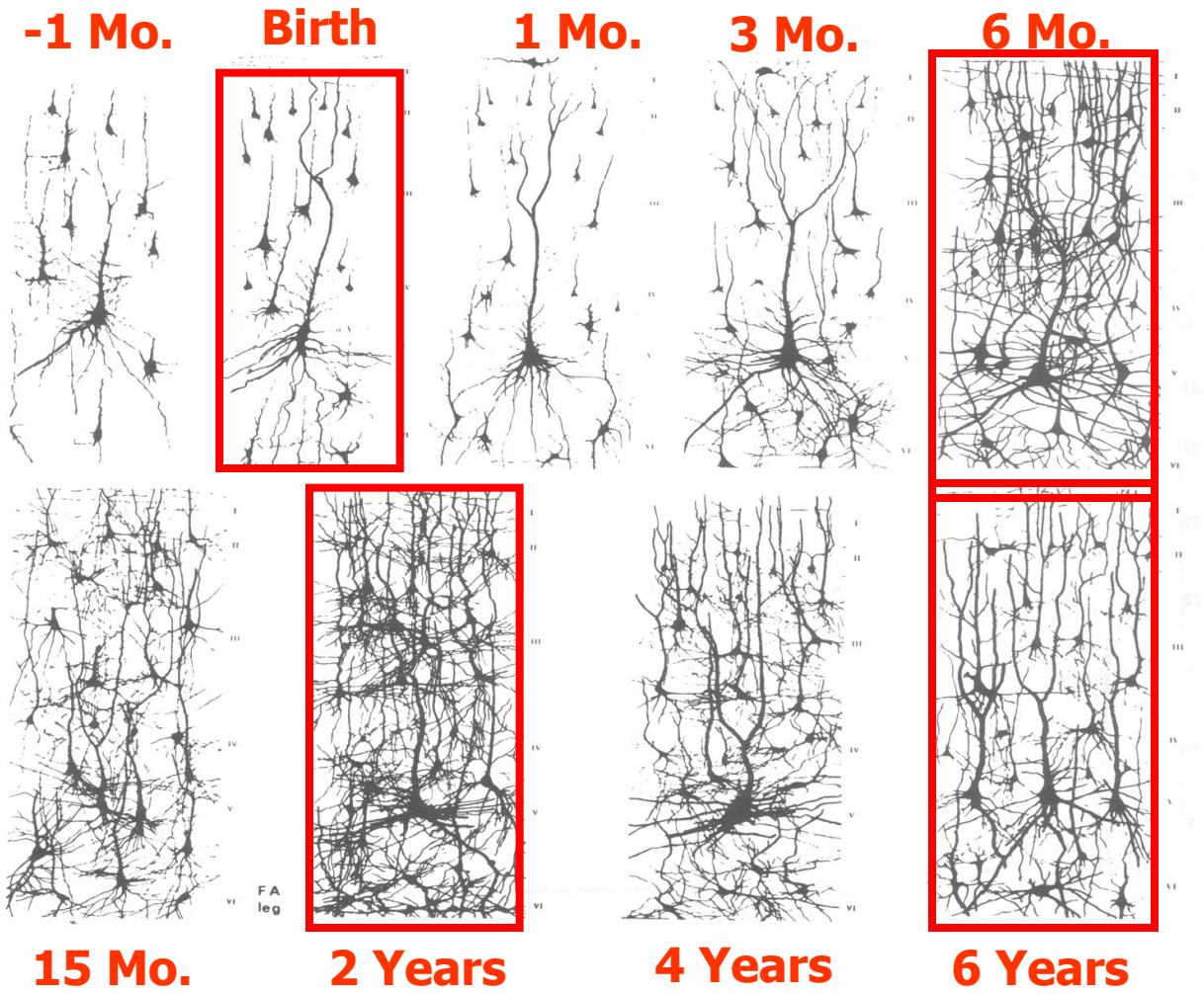



USE IT OR
LOSE IT

- No sensory system exists in isolation
- Non-auditory effects of deprivation – attention, working memory, executive functioning etc

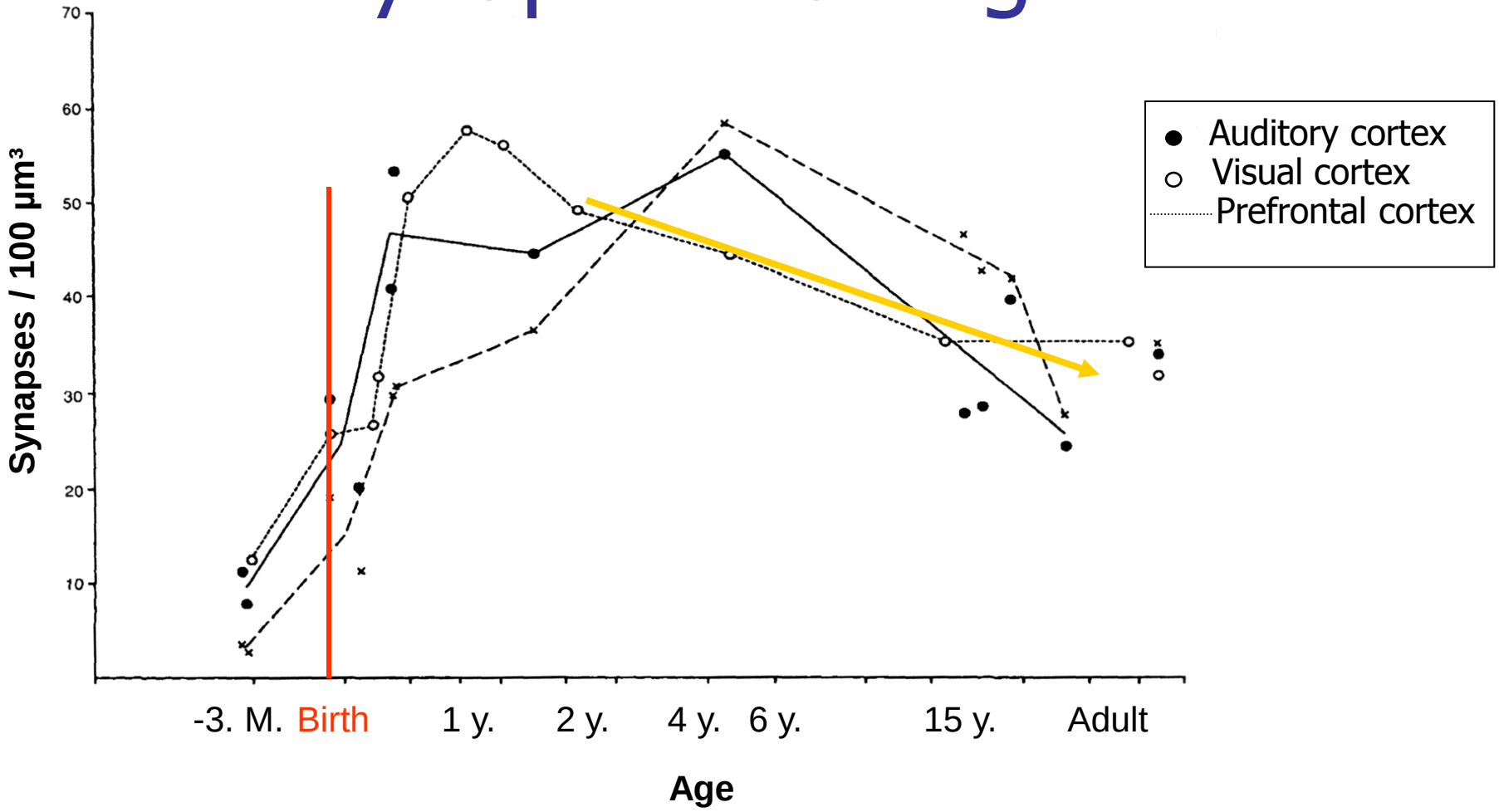


Development Human Cortex



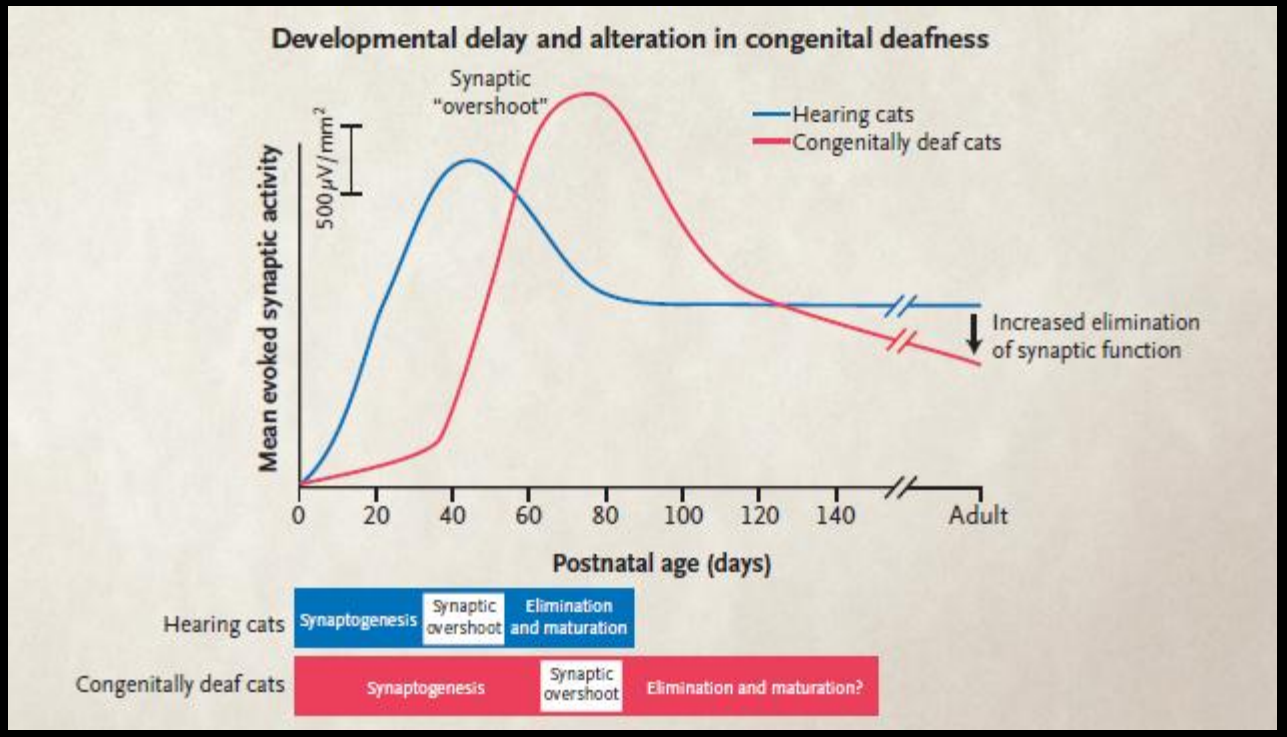
Conel, 1939-1967

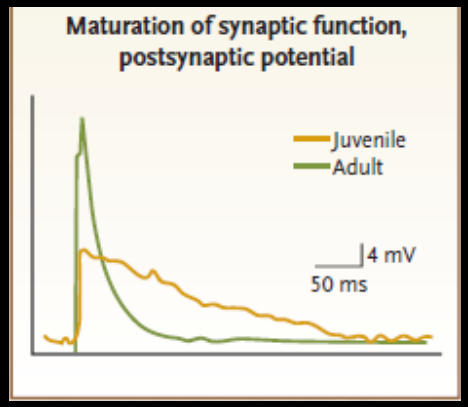
Synaptic Pruning



Huttenlocher, Dabholkar 1997, J Comp Neurol 387:167-178.

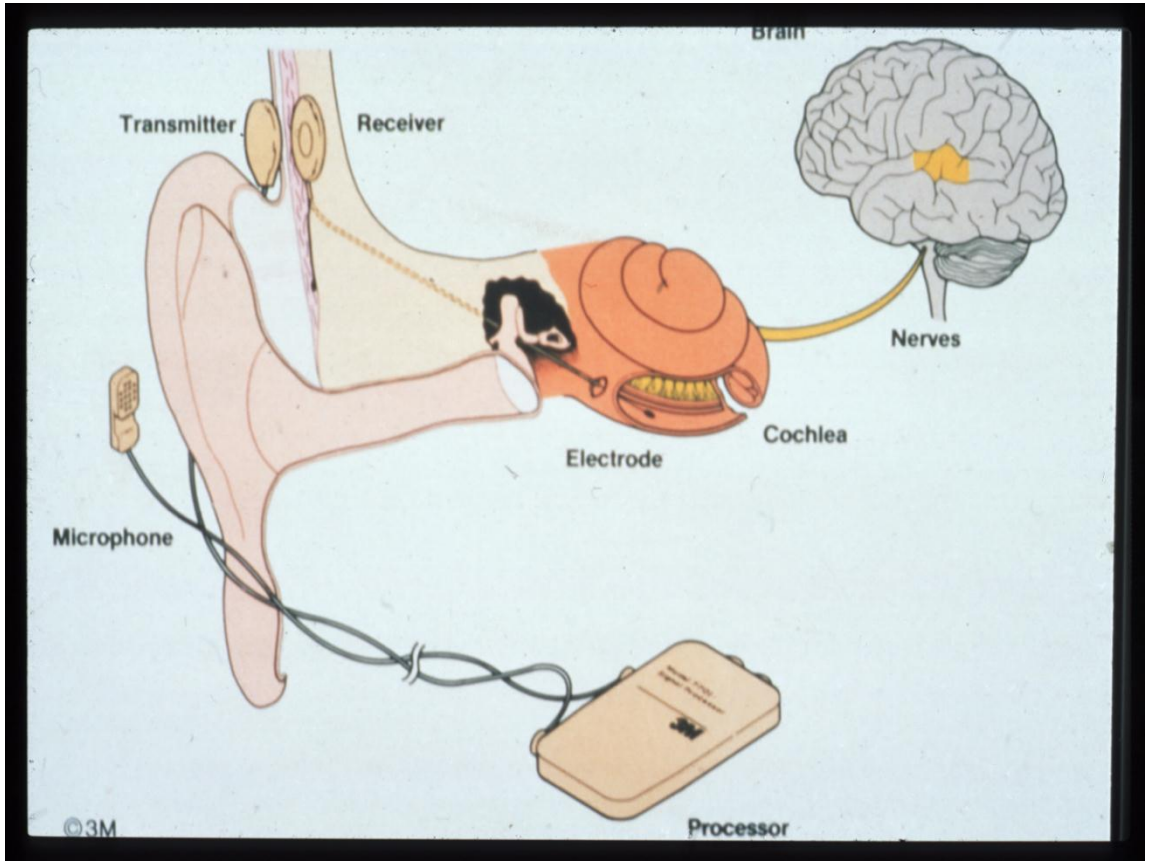
Synaptic Maturation



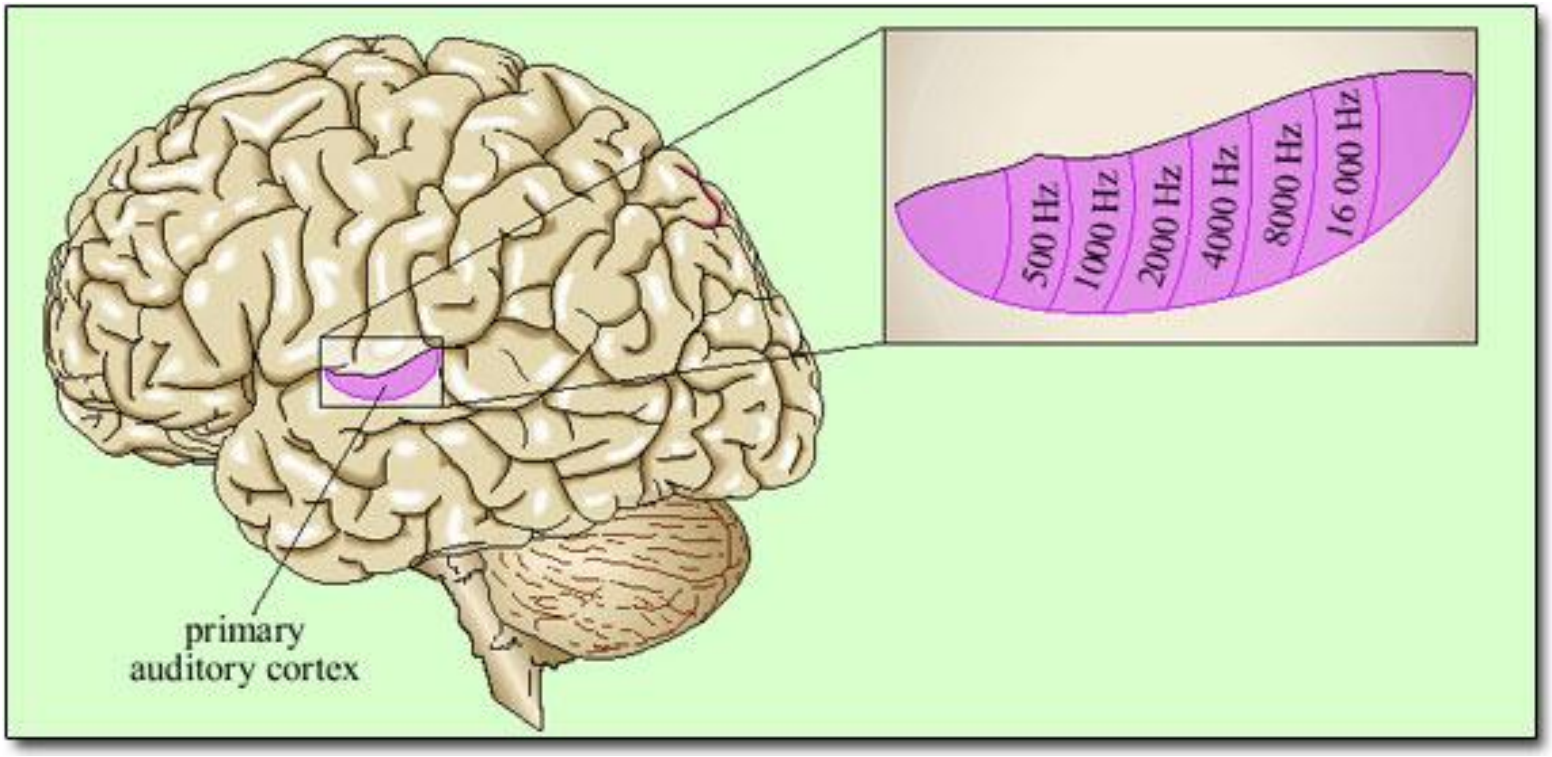


Kral and O'Donoghue, New Eng J Med 2010

Cochlear Implants and Plasticity



Cochleotopic Organisation of Cortex - CI



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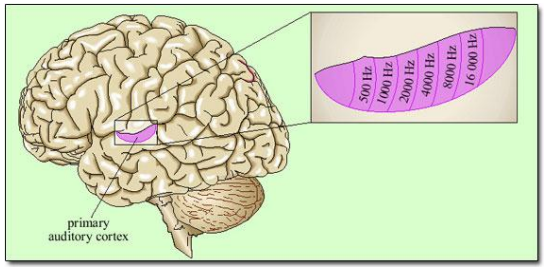
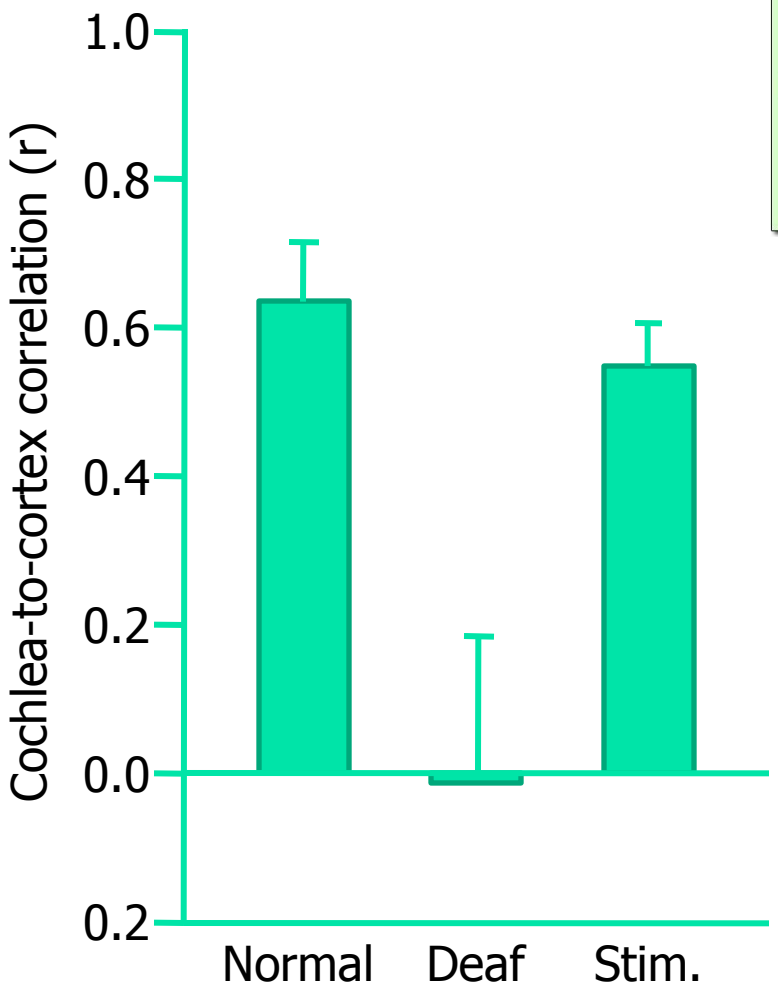
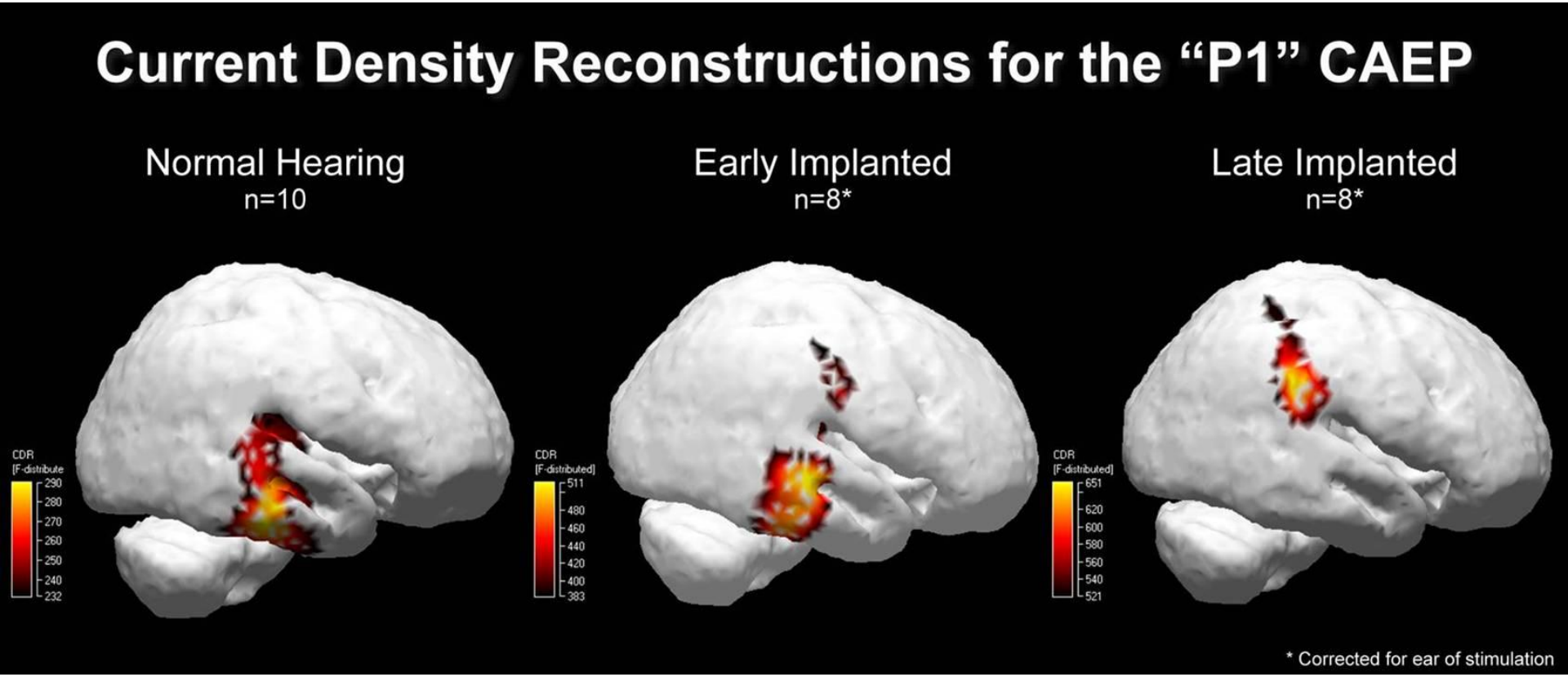




(Fallon et al., 2009)

Cross modal reorganisation after CI



Dorman et al 2009

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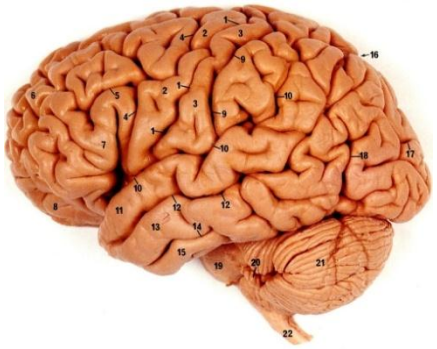
Plasticity into Practice

[Carol Flexer]

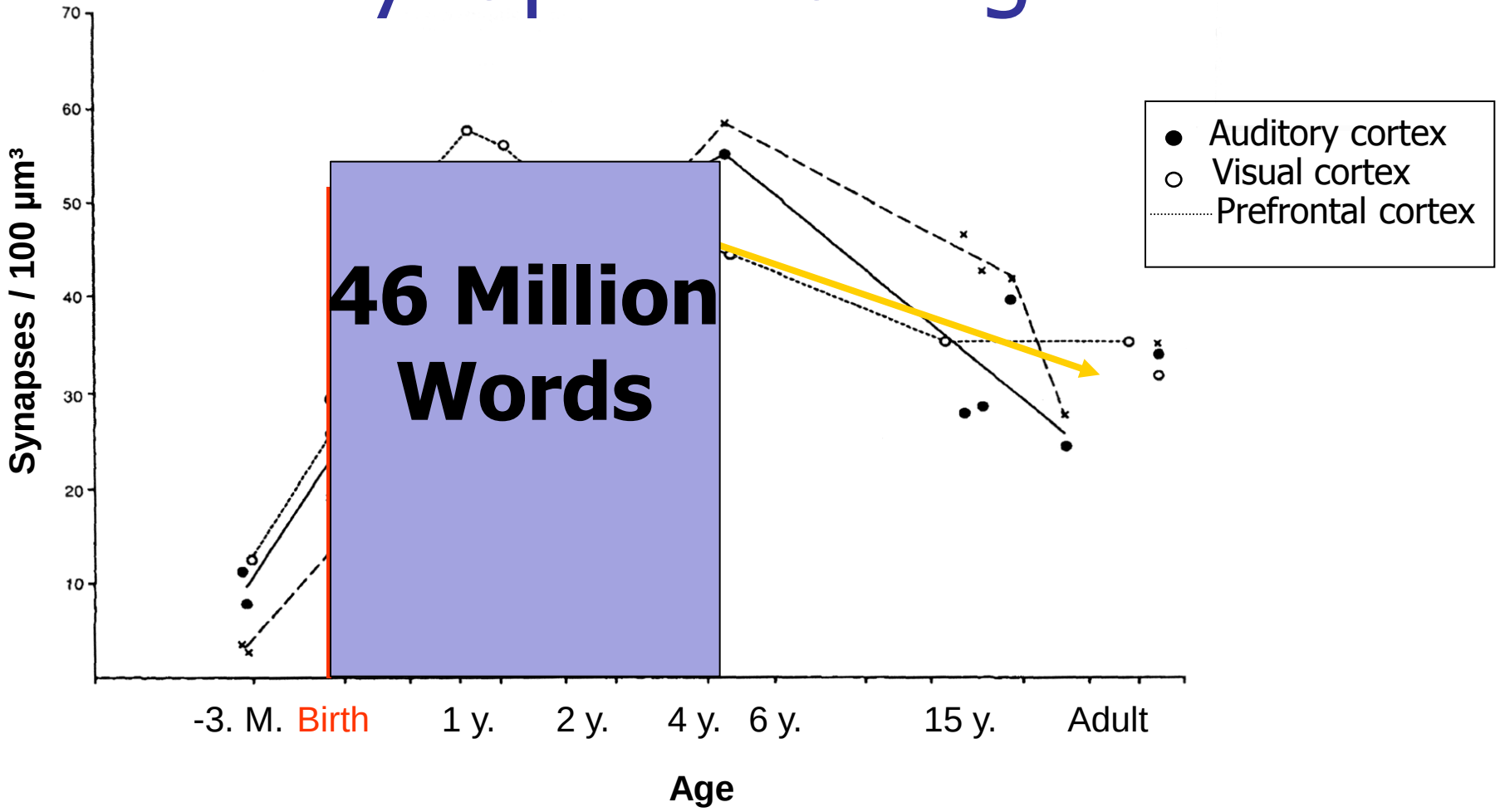


- Not about ears: its all about the brain
- Prostheses: *brain access tools*
- 'Its not what we hear, its what we do with what we hear'

Plasticity in Practice

- 46 million words heard by age 4 *(Hart and Risley)*
- 20,000 hours listening for reading *(Dehaene)*
- Hearing loss: 3 times exposure to learn new words / concepts (Pittman)
- Acoustically favourable conditions

Synaptic Pruning



Huttenlocher, Dabholkar 1997, J Comp Neurol 387:167-178.

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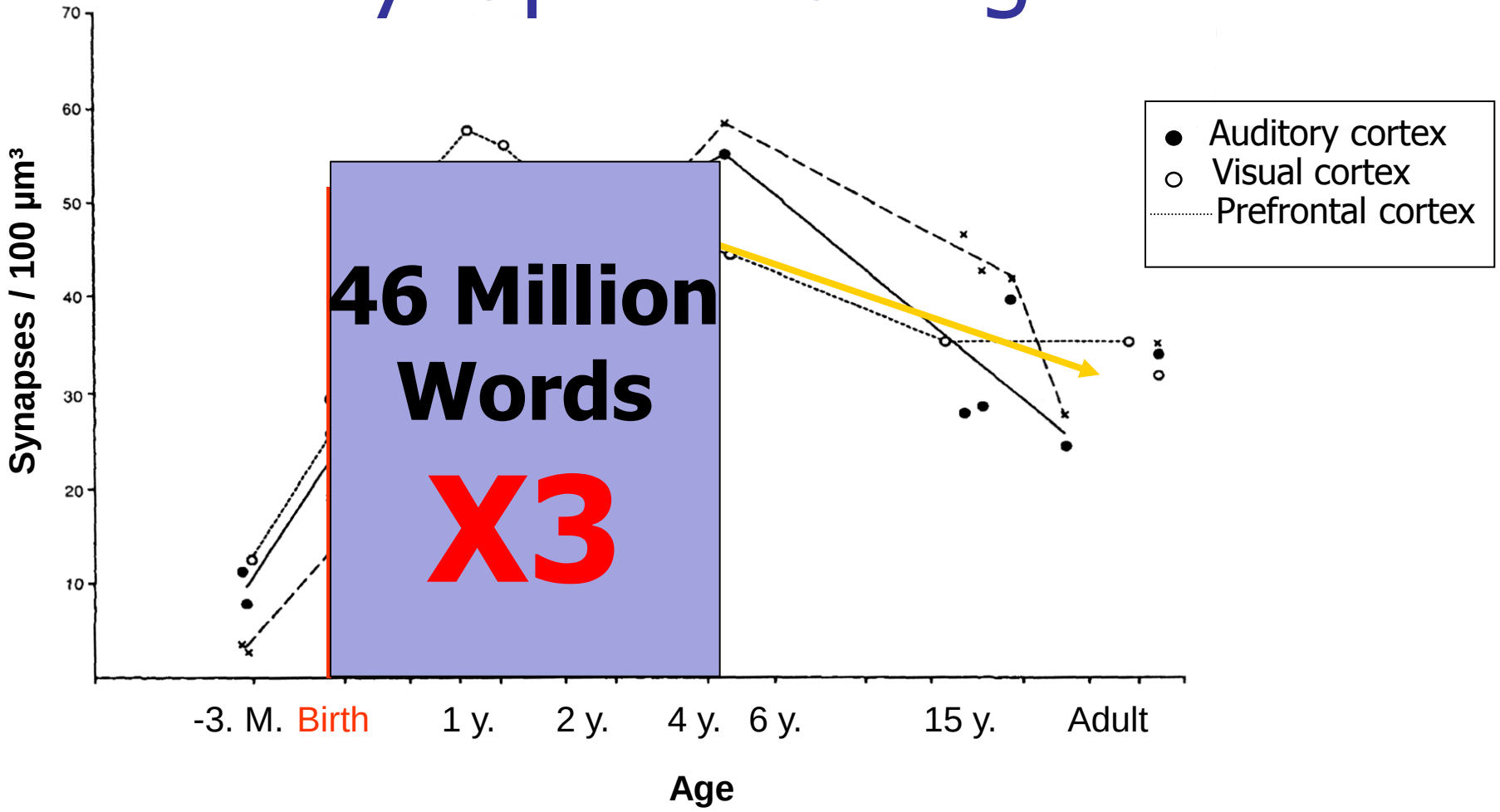

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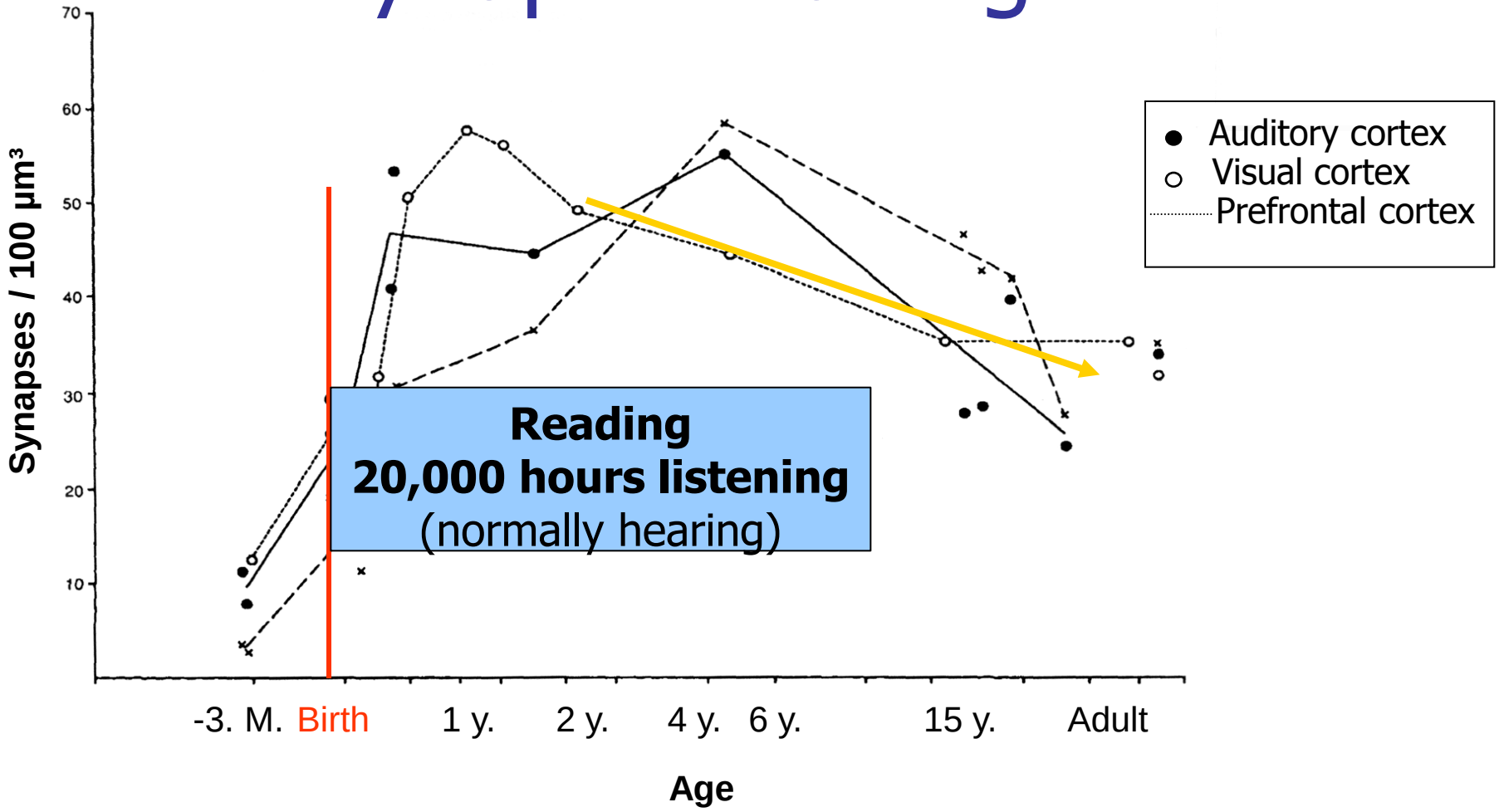
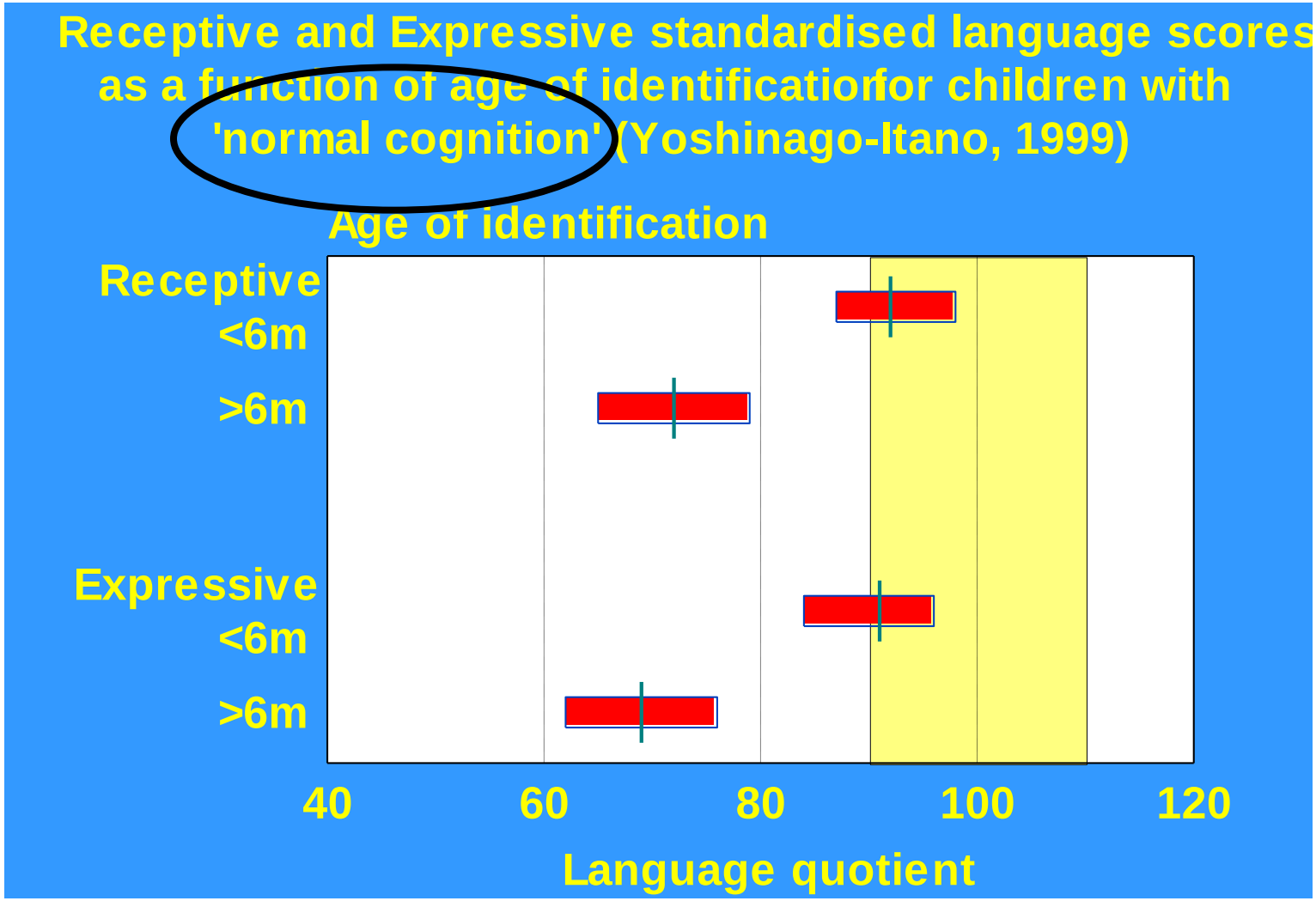
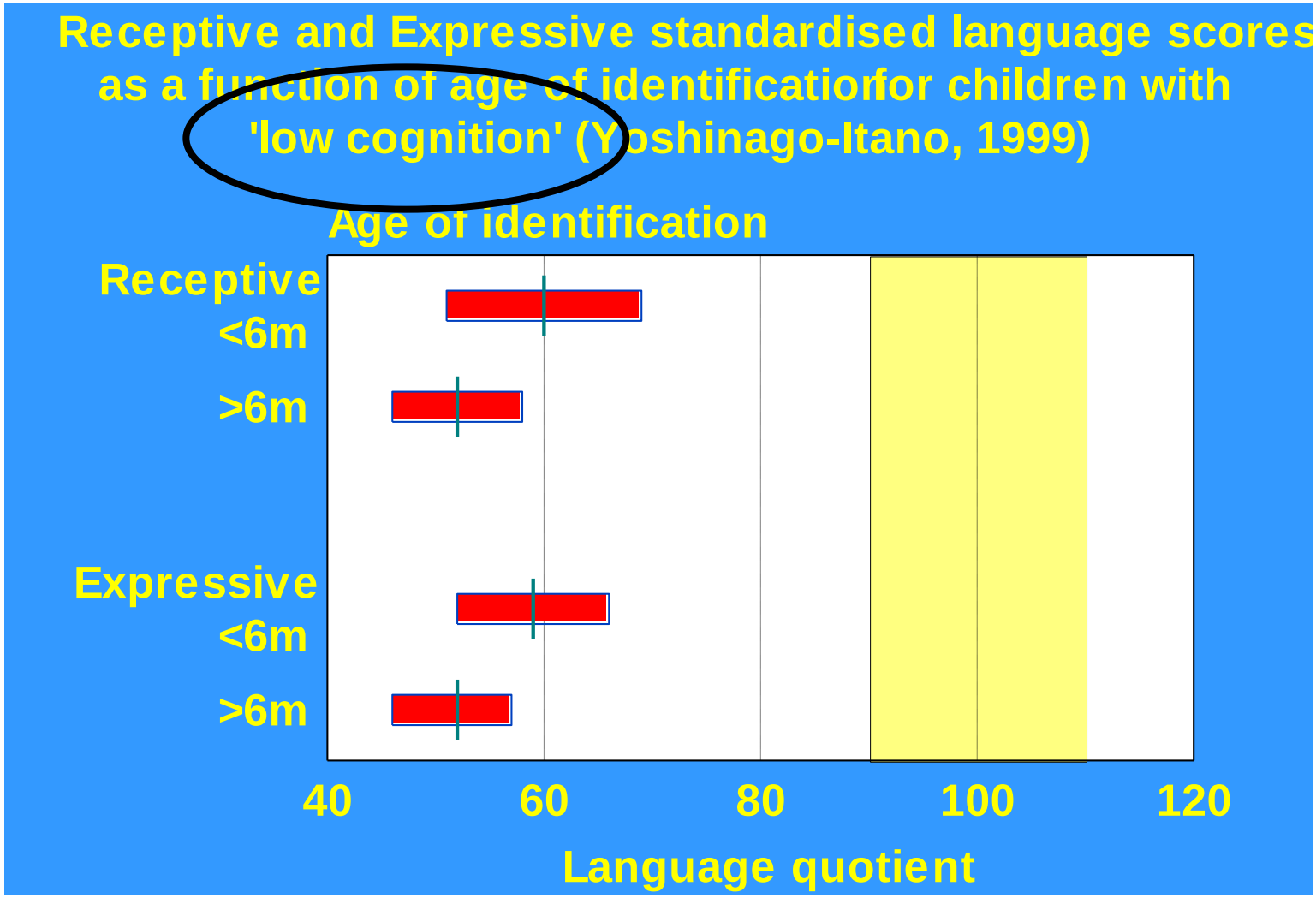


Huttenlocher, Dabholkar 1997, J Comp Neurol 387:167-178.

Early intervention



Early intervention



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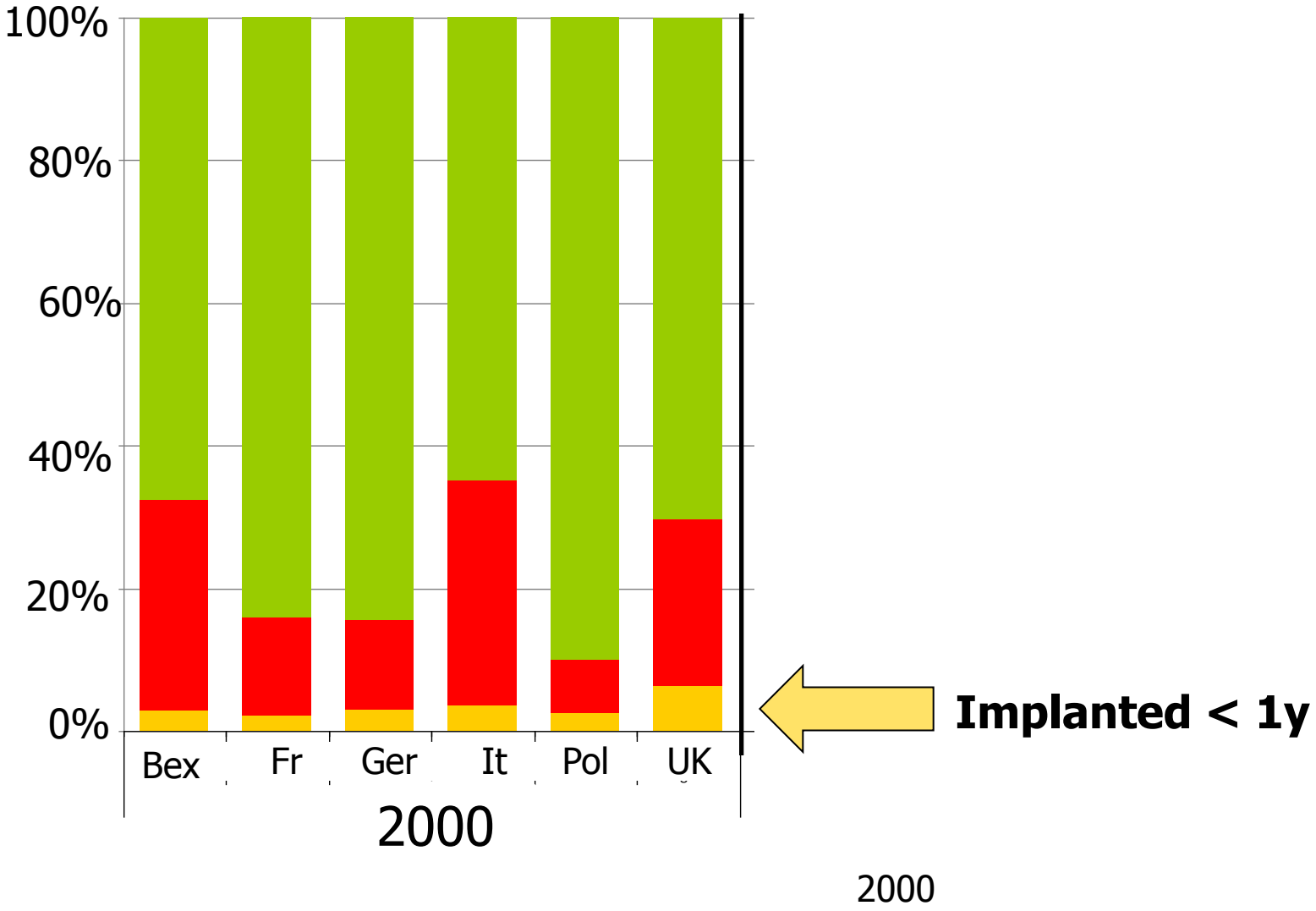
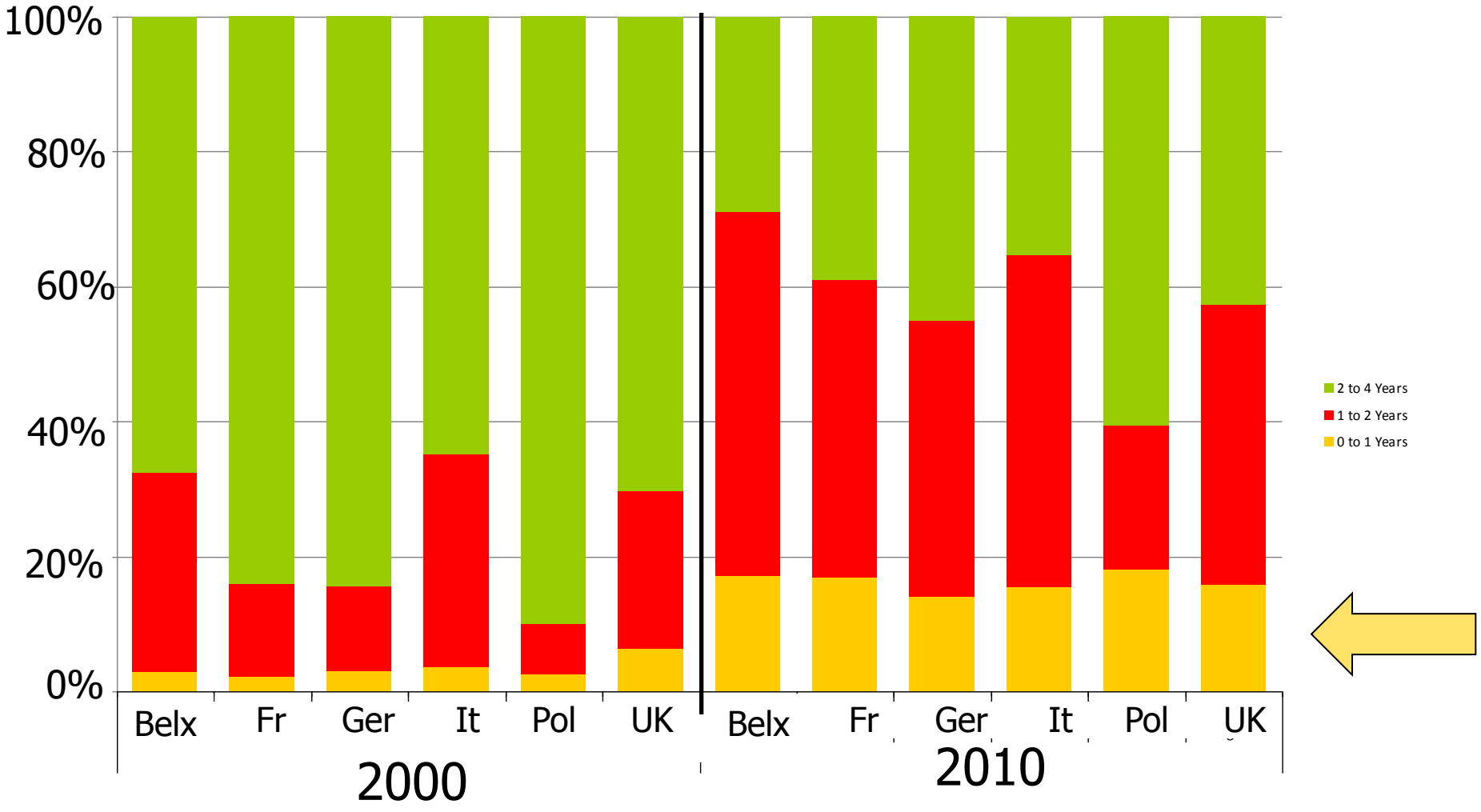
Early Cochlear Implantation

Age at implant 0-4 years 2000 to 2010



Source: Cochlear Ltd database

Age at implant 0-4 years 2000 to 2010



Source: Cochlear Ltd database

Audiological Certainty

- What age?
- What measures?
- What validity?
- Who decides?
- Parameters of hearing aid trial

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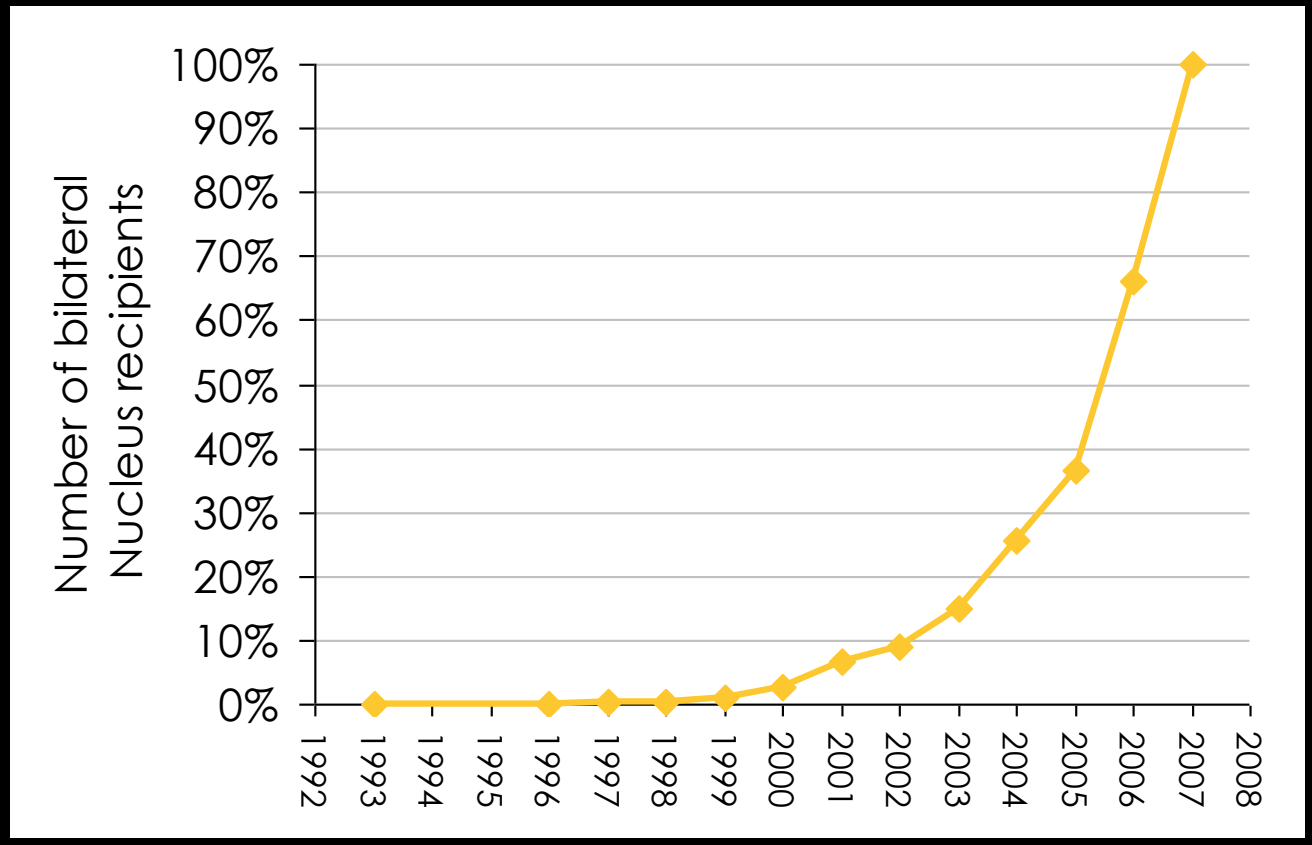
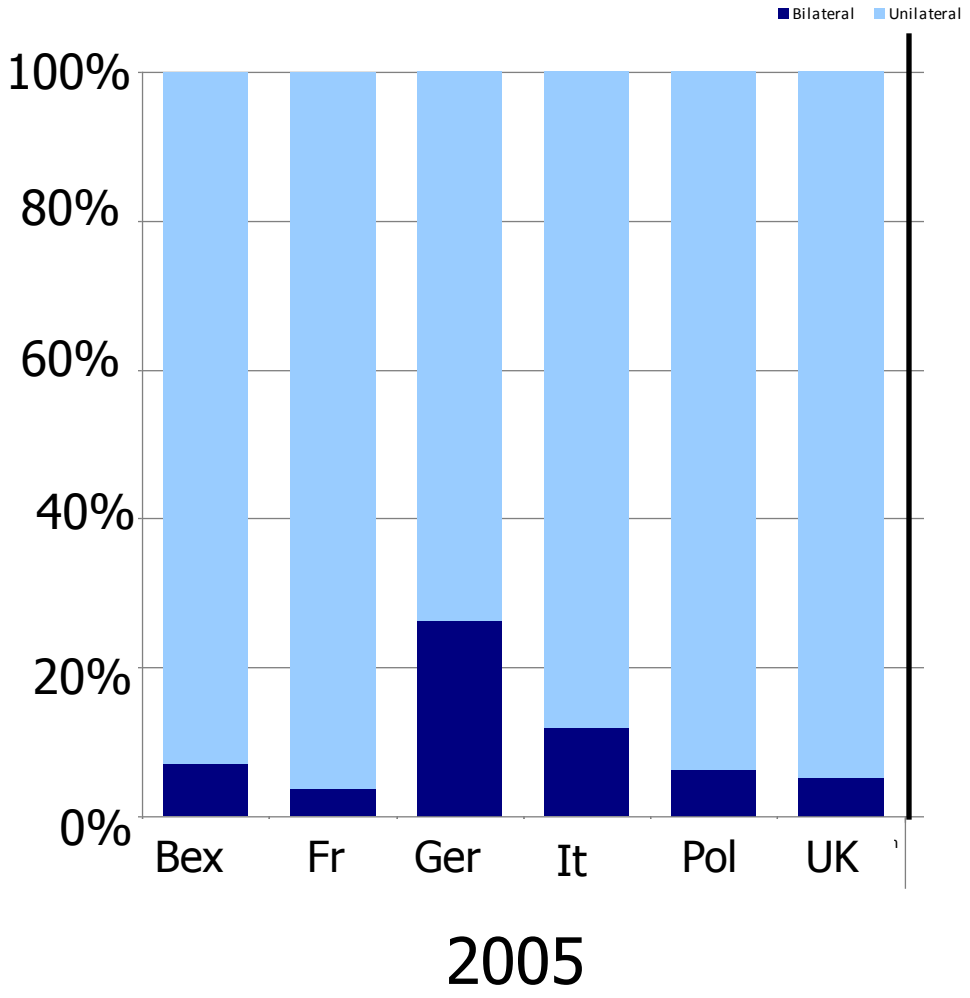
European Data - Bilaterals



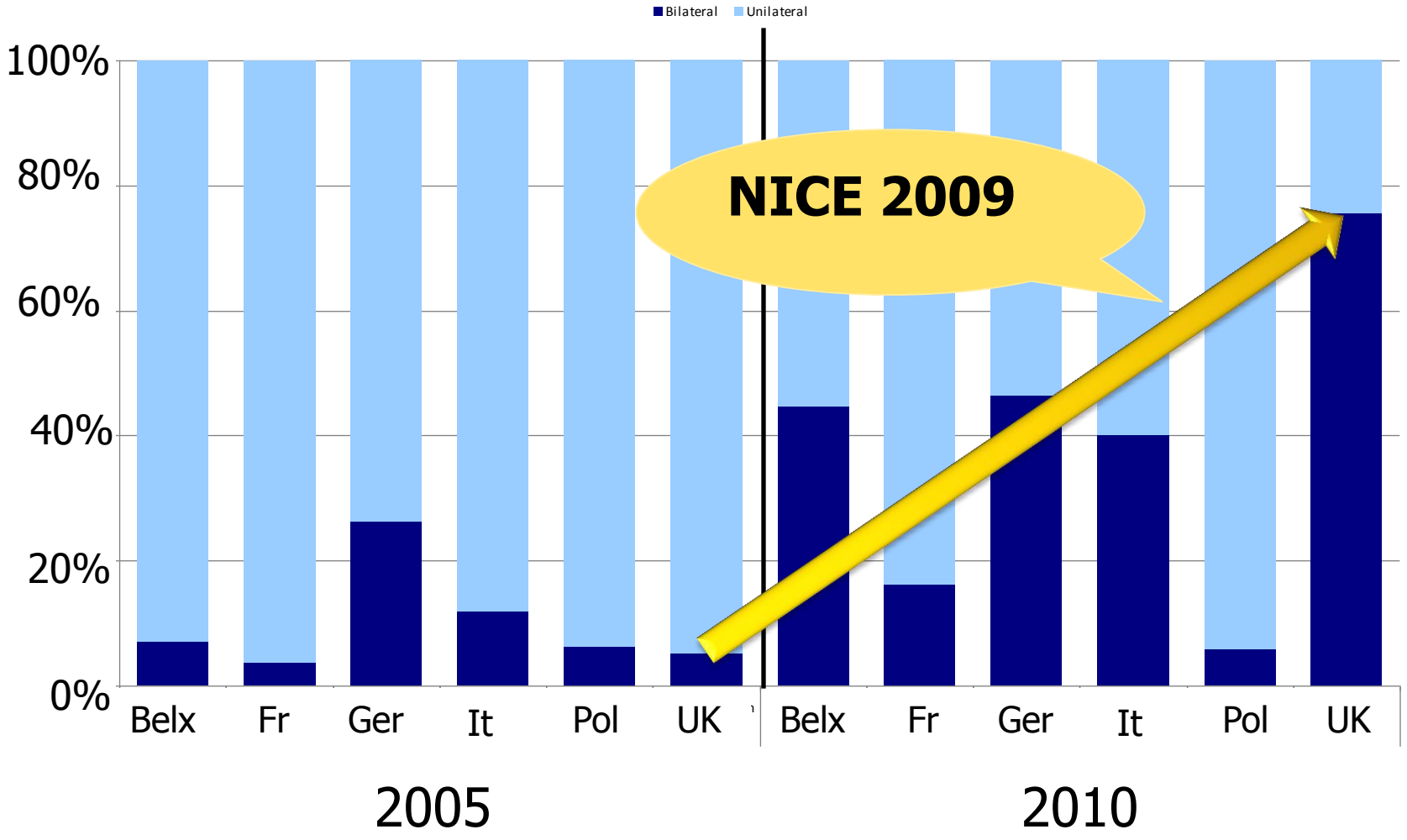
Source: Cochlear Ltd database

Bilateral implants children 2005:2010



Source: Cochlear Ltd database

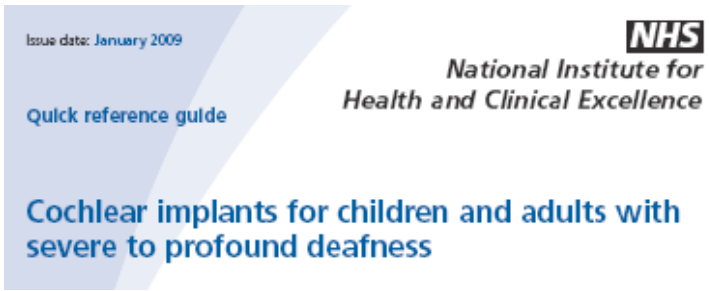
Bilateral implants children 2005:2010



Source: Cochlear Ltd database

Bilaterals – UK Provision

- Bilateral implantation recommended for children & some adults
  - Simultaneous
  - Additional contralateral



National Audit Bilaterals: *UK*

- Localisation
- Speech recognition in background noise
- Speech
- Language
- Listening
- Parental perception
- Quality of life
- Surgical data including complications

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Surgical challenges - BICI

- Minimal Access Surgery
- Operating time
- Anesthesia
- Facial nerve injury
- Co-morbidity – known or unknown
- Electrocautery
- Loss vestibular function / residual hearing
- Meningitis risk

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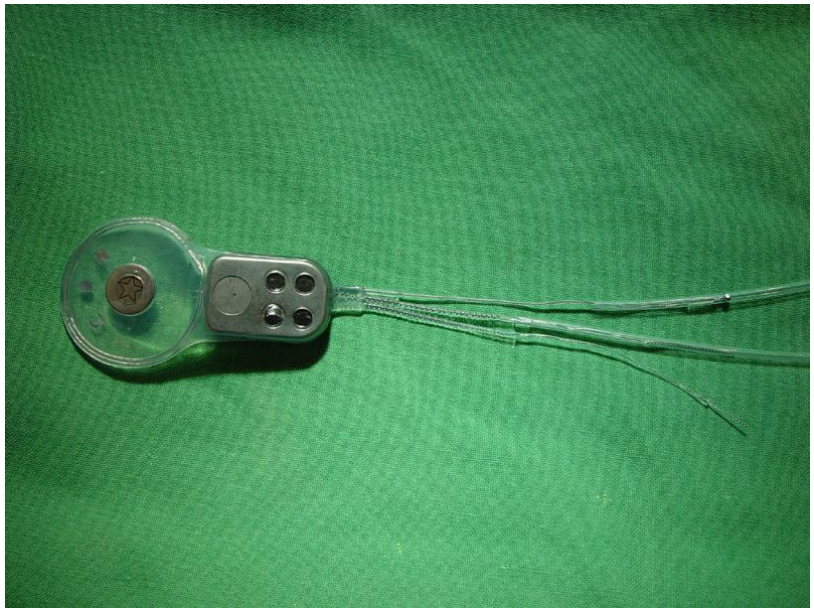
Hearing aids + Implants

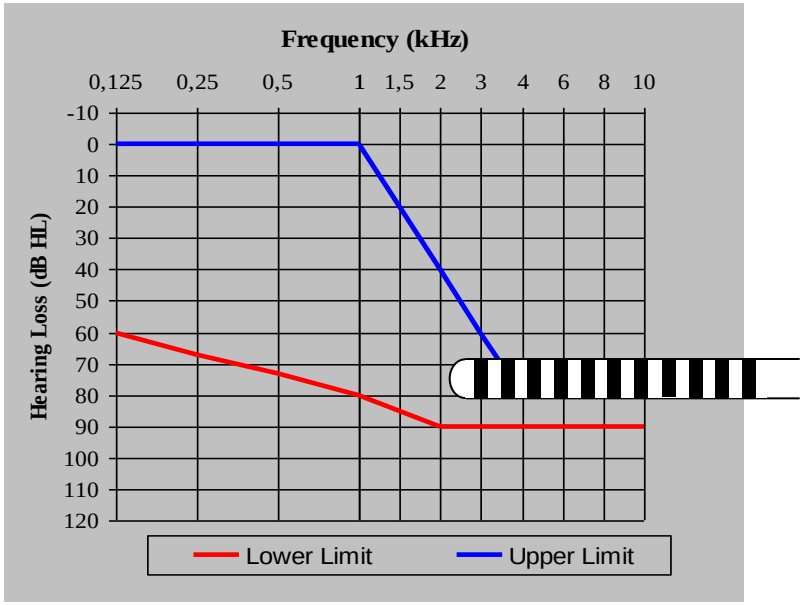
Electrical Stimulation

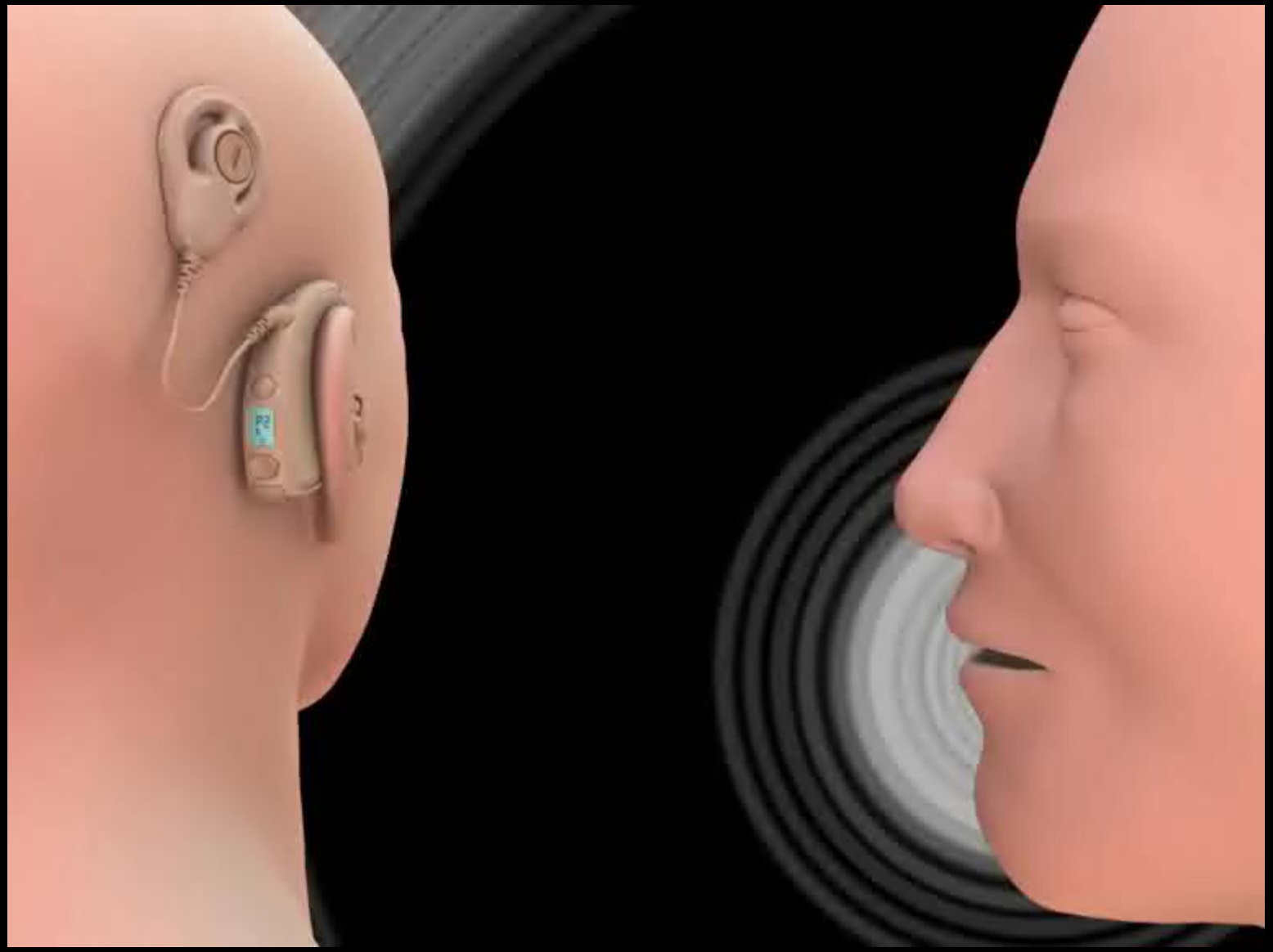
&

Acoustical Stimulation

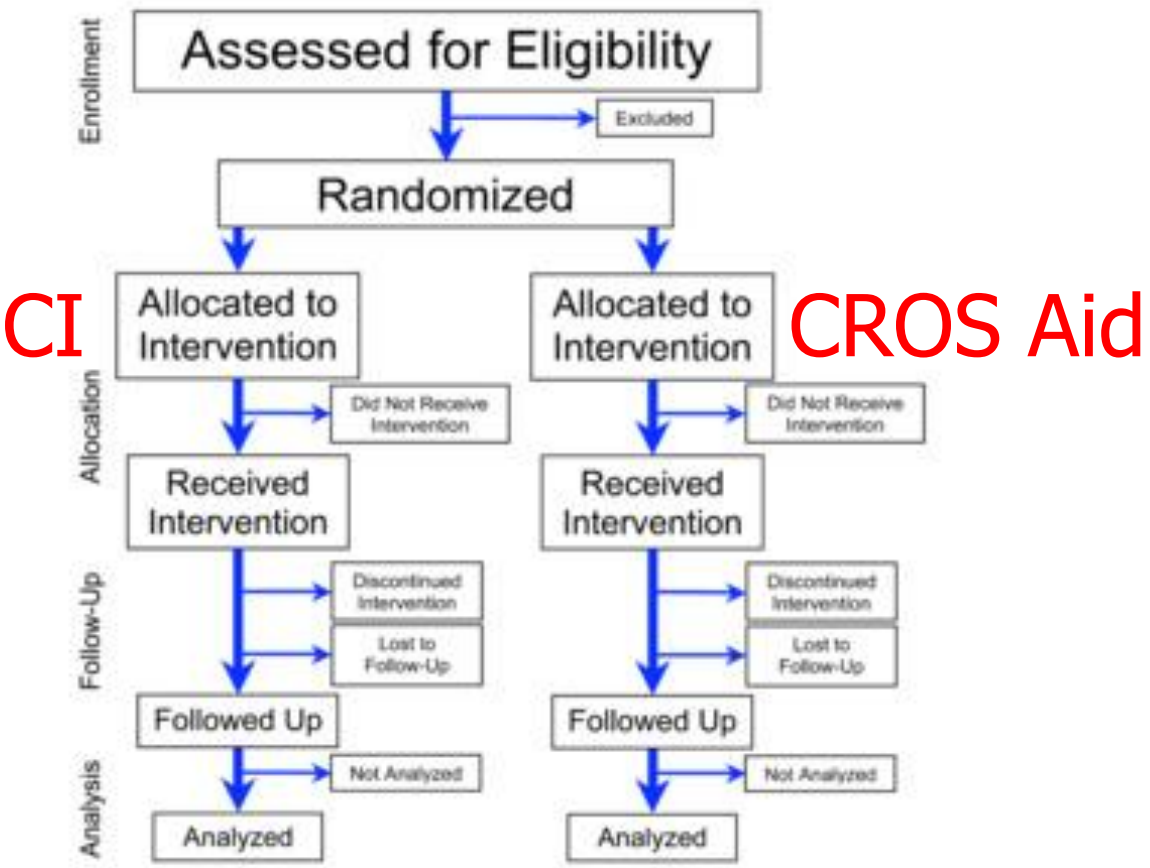
Electro-acoustic hearing



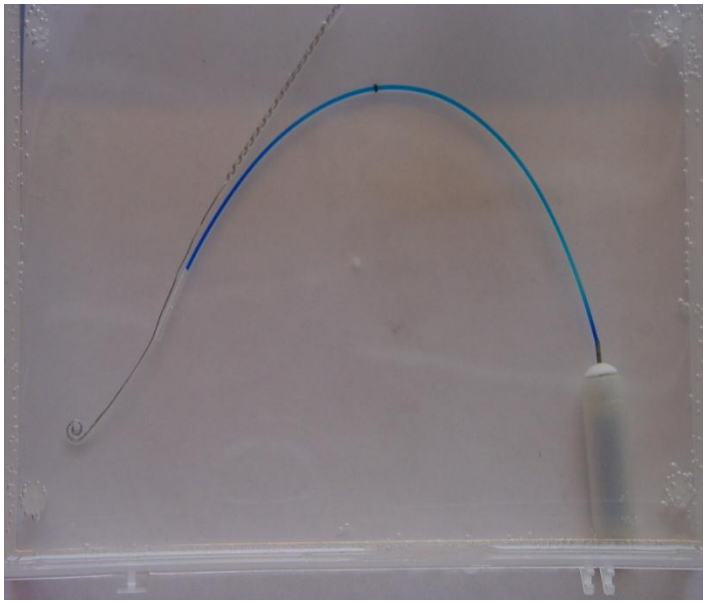


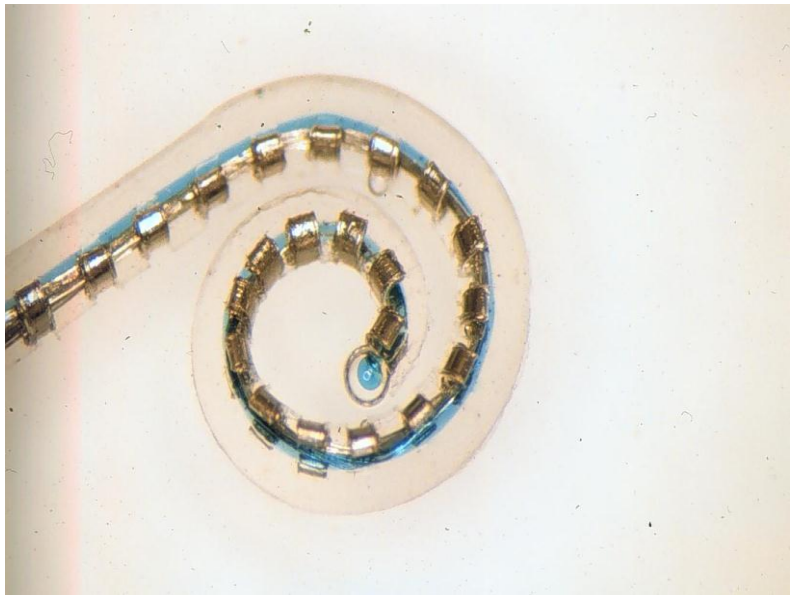


Single Side Deafness and CI



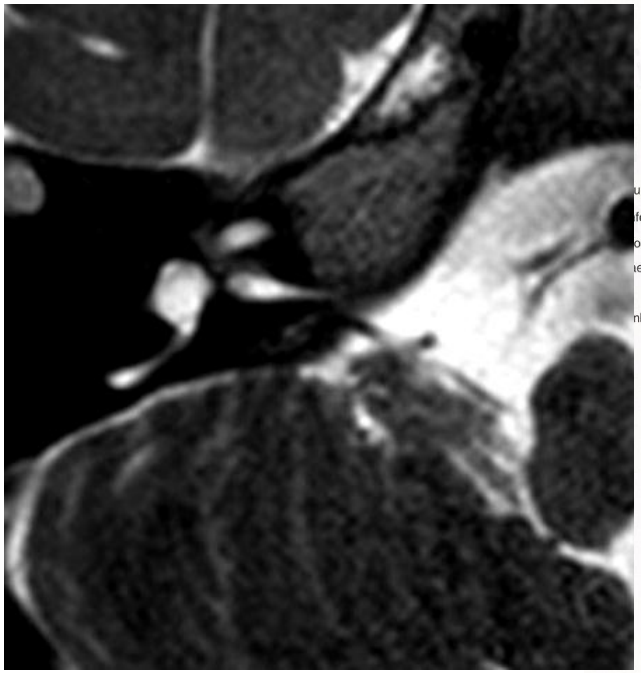
Advances in Implant Technology

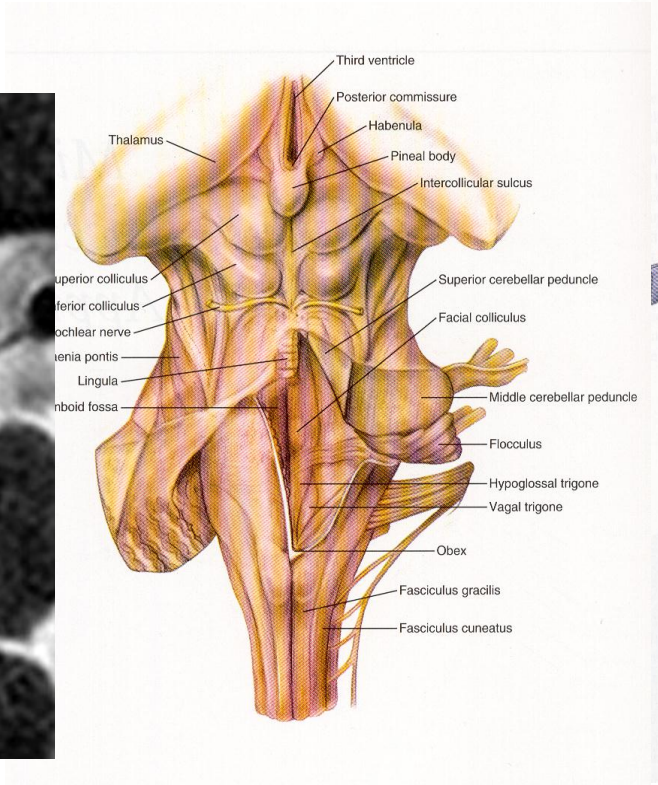


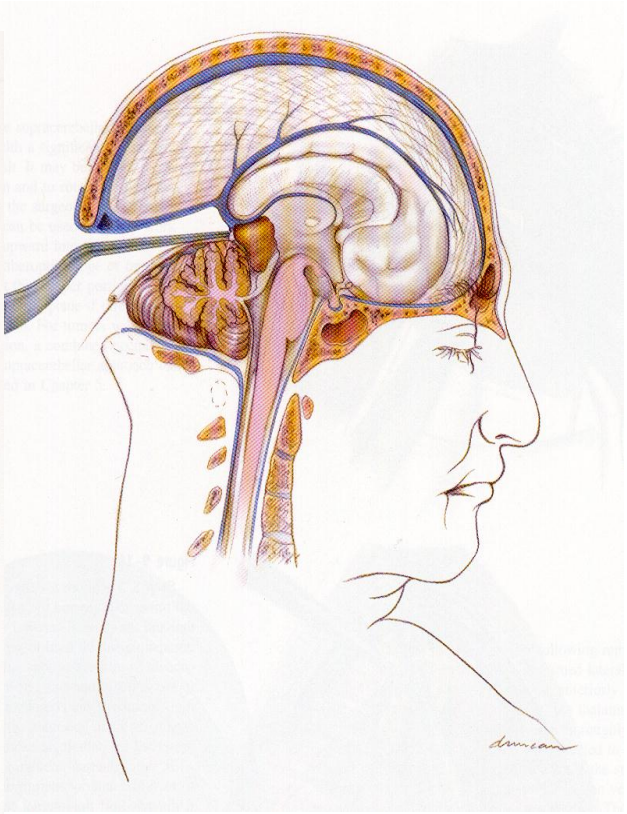


Drug and Stem Cell delivery systems

Auditory Brainstem Implant







(Lenarz et al , Colletti et al 2006)

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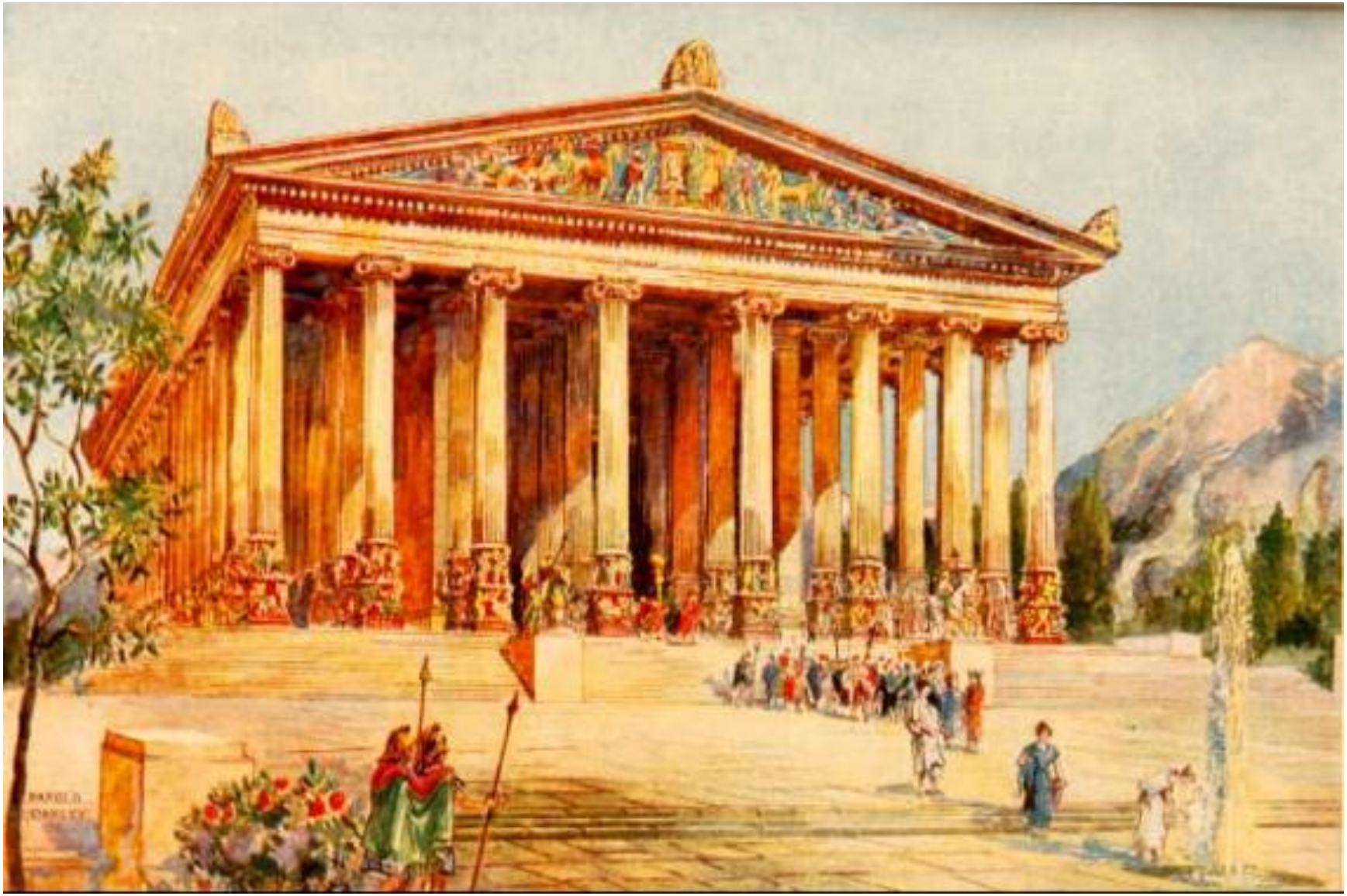
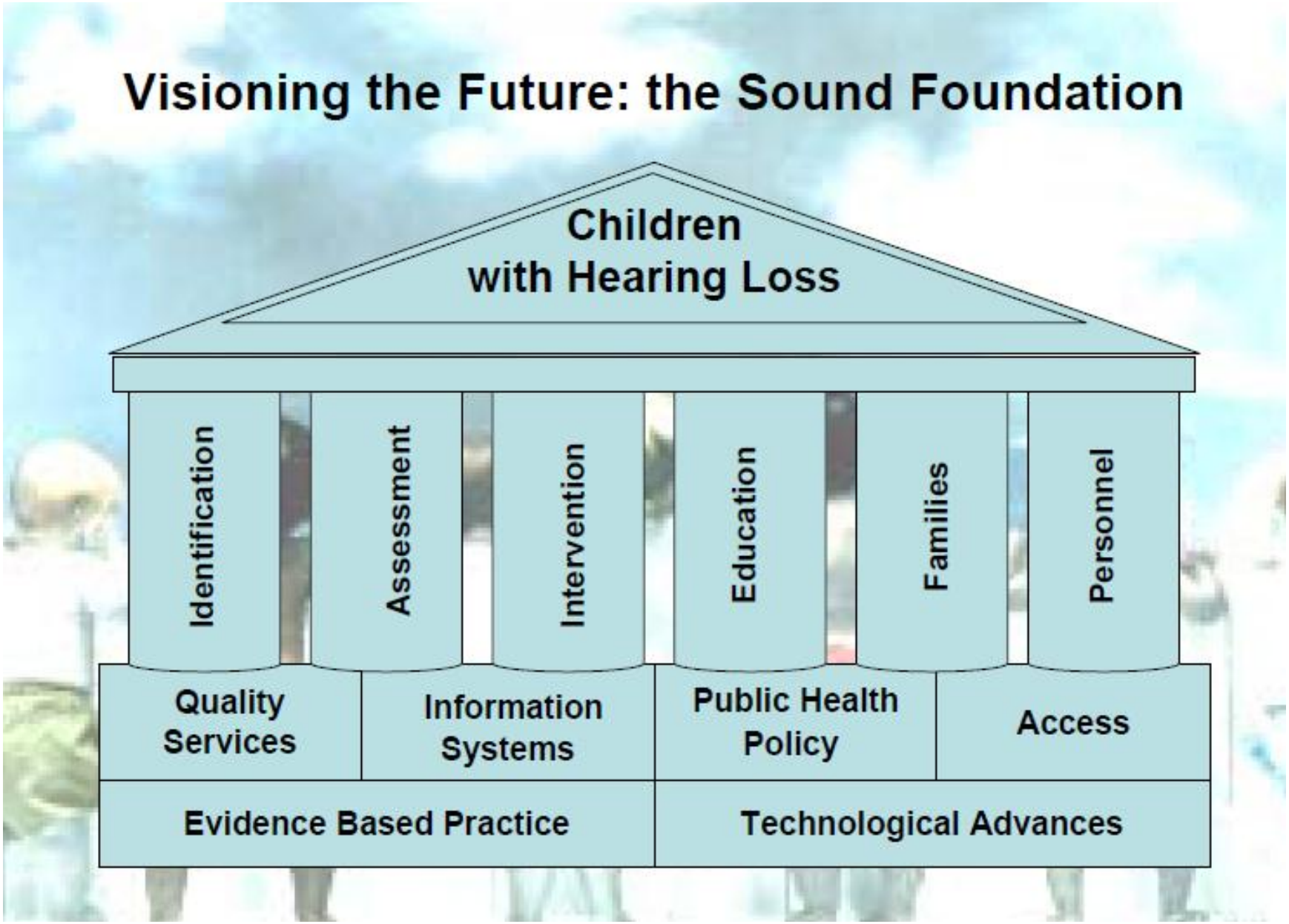


Temple of Artemis

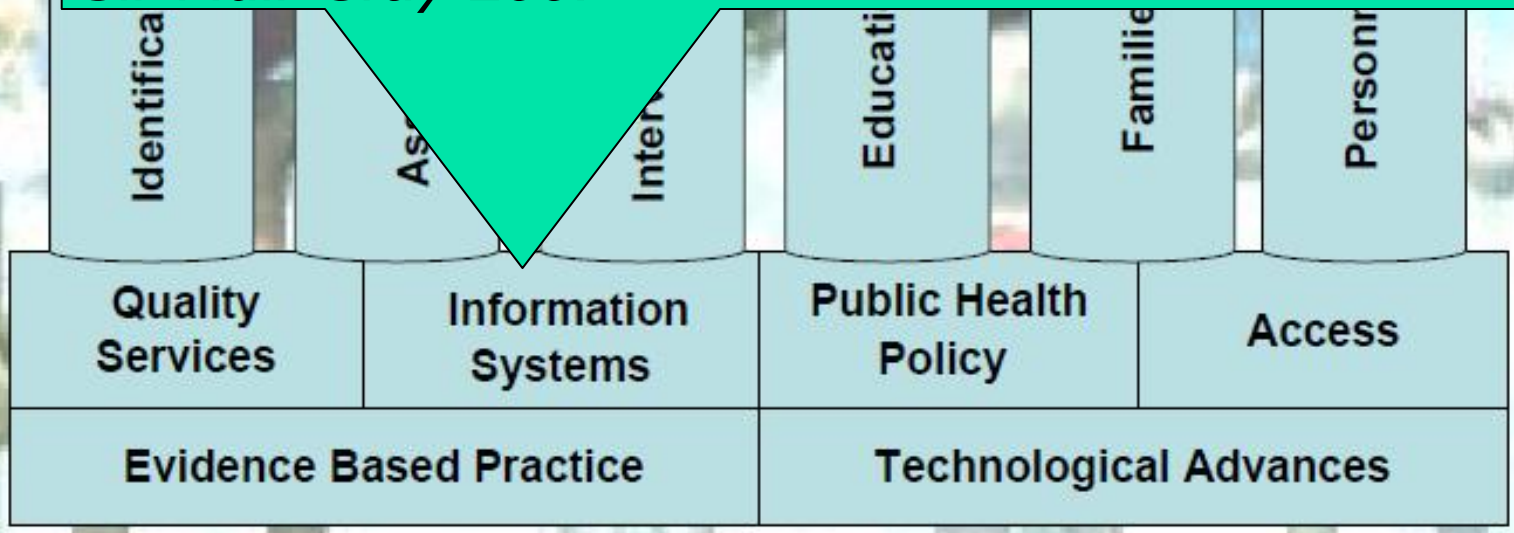
Visioning the Future: the Sound Foundation



J. Gravel 2007

Information and systems give meaning to everything we do; there is no point in going through the motions of providing a service if there are no systems on which to support, record or monitor the process and outcomes

Sir Muir Gray 2007



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Summary

- Deafness - not just about hearing loss
- Prostheses as brain access tools
- Earlier is best - *but not a cure!*
- Bilateral CI - timely, safe, efficient
- Combined acoustical and electrical hearing
- Audiological certainty - central
- Paediatric audiology 'Temple'