

Vision and audition : gain from bimodality in speech comprehension in cochlear implanted deaf patients

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Visuo-auditory processing in speech comprehension in cochlear implanted patients

- Performances post-implantation.
- Strategies
- Cortical network associated



-278 millions people (\approx 20%) with disabling hearing impairment (WHO, 2005)



USA

- 24 million people with hearing impairments**
- 2.4 million visually disabled**
- 1 million wheelchair users**

Life-threatening difficulties

- communication**
- education**
- keep employment**

Heavy social and economic burden

- The societal costs of severe to profound hearing loss in the US is estimated to be \$297,000 per person during that person's life. (Int J. Techn Health Care 2000 vol 16).

Causes of hearing loss



Conductive hearing loss

- Cholesteatoma
- Chronic middle ear fluid
- Middle ear infection
- Obstruction of external ear canal
- Otosclerosis
- Perforated eardrum

Sensorineural hearing loss

- Aging
- Brain tumors
- Drugs
- Childhood infections
- Congenital infection
- Congenital abnormality
- Demyelinating diseases
- Genetic
- Loud noise
- Meniere's disease
- Sudden pressure changes
- Viral infection of the inner ear

Grade of impairment	Corresponding audiometric ISO value	Performance	Recommendations
0 - No impairment	25 dB or better (better ear)	No or very slight hearing problems. Able to hear whispers.	
1 - Slight impairment	26-40 dB (better ear)	Able to hear and repeat words spoken in normal voice at 1 metre.	Counselling. Hearing aids may be needed.
2 - Moderate impairment	41-60 dB (better ear)	Able to hear and repeat words spoken in raised voice at 1 metre.	Hearing aids usually recommended.
3 - Severe impairment	61-80 dB (better ear)	Able to hear some words when shouted into better ear.	Hearing aids needed. If no hearing aids available, lip-reading and signing should be taught.
4 - Profound impairment including deafness	81 dB or greater (better ear)	Unable to hear and understand even a shouted voice.	Hearing aids may help understanding words. Additional rehabilitation needed. Lip-reading and sometimes signing essential.

Grades 2, 3 and 4 are classified as **disabling hearing impairment**.

The audiometric ISO values are averages of values at 500, 1000, 2000, 4000 Hz.



SON



1

oreille externe

VIBRATIONS SONORES

2

oreille moyenne

VIBRATIONS SONORES

3

oreille interne

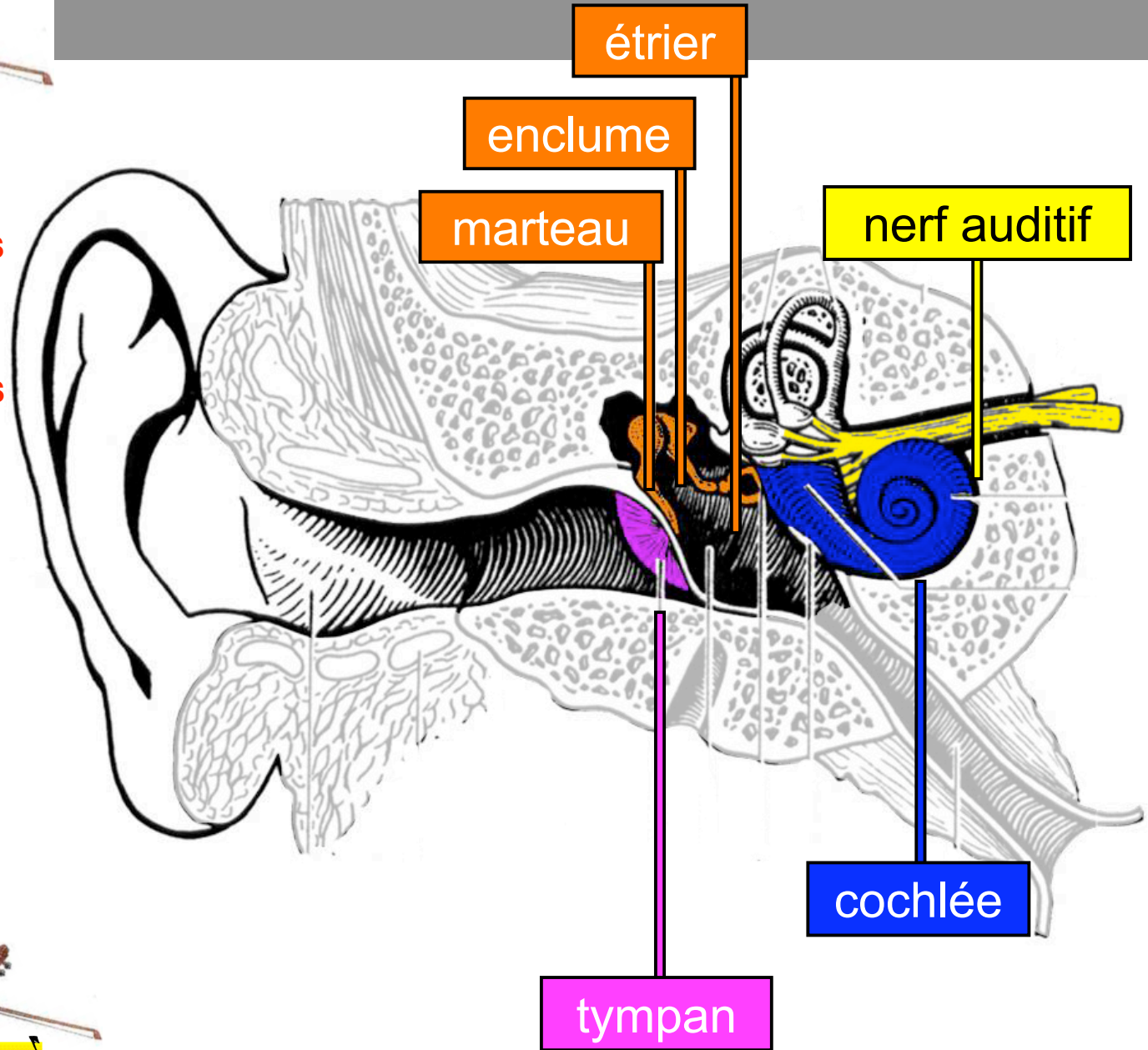
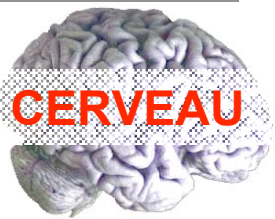
IMPULSIONS
ELECTRIQUES

4

nerf auditif

IMPULSIONS
ELECTRIQUES

CERVEAU



SON



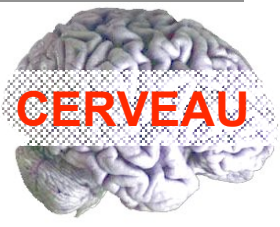
**Implant
cochléaire**

**IMPULSIONS ELECTRIQUES
ARTIFICIELLES**

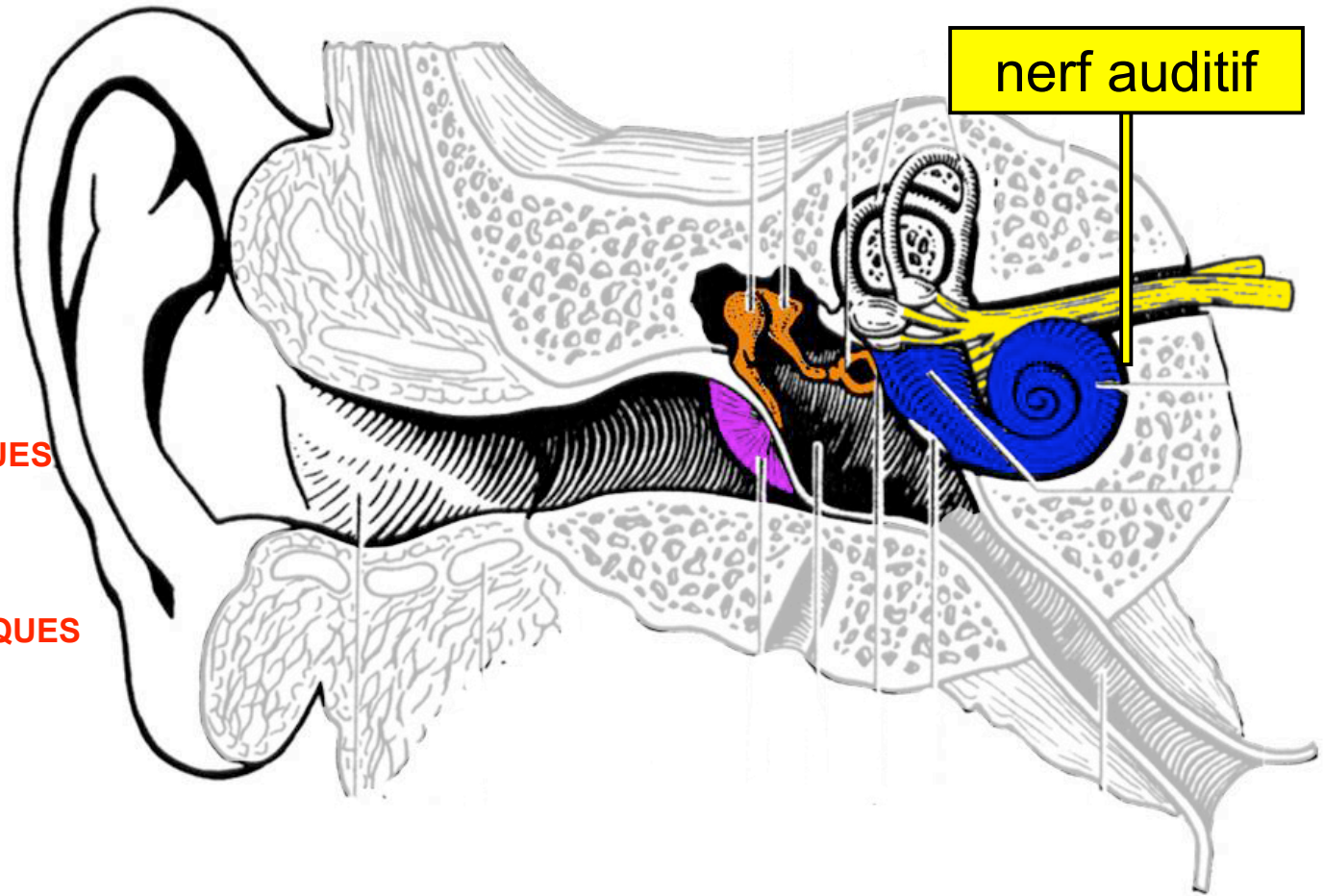
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nerf auditif

IMPULSIONS ELECTRIQUES

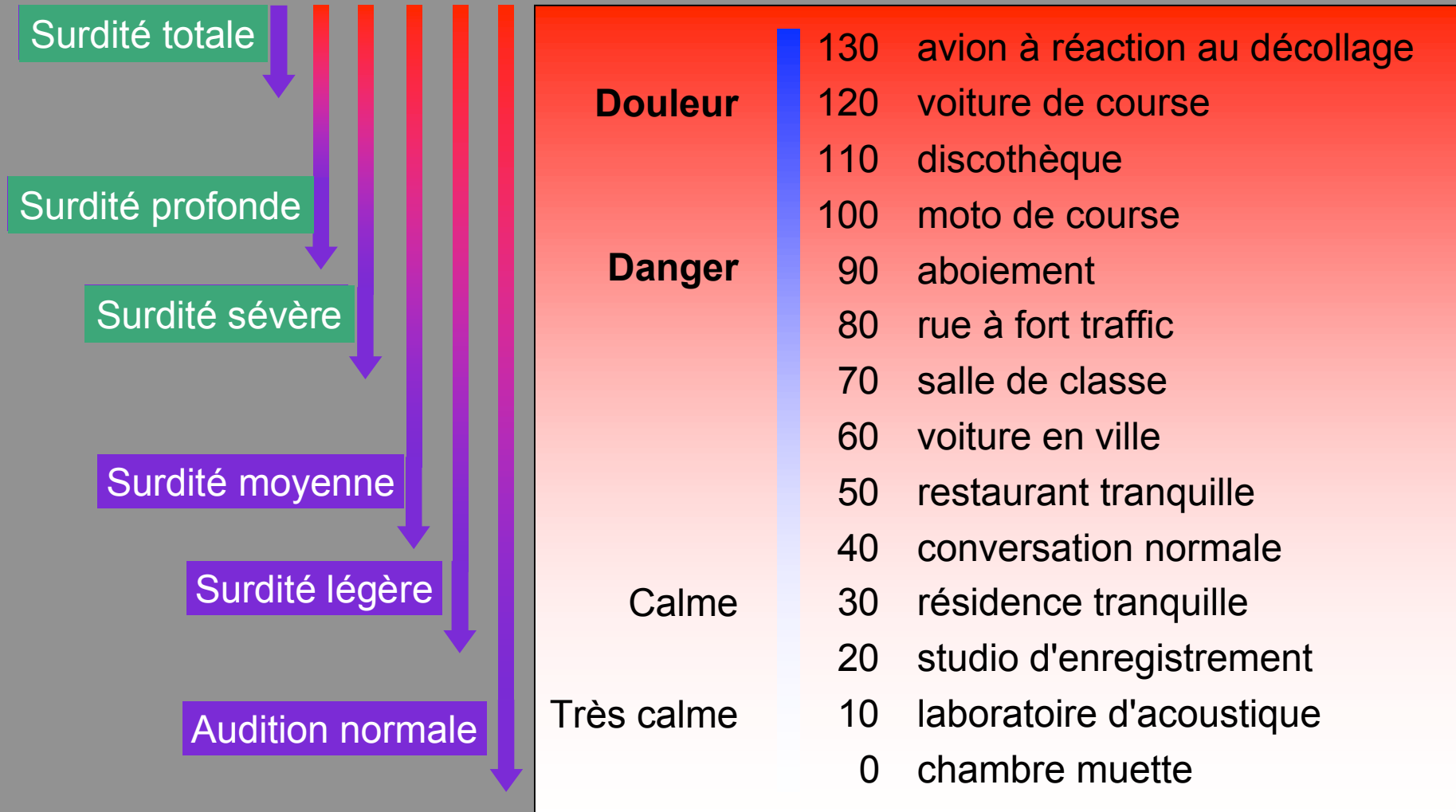


CERVEAU



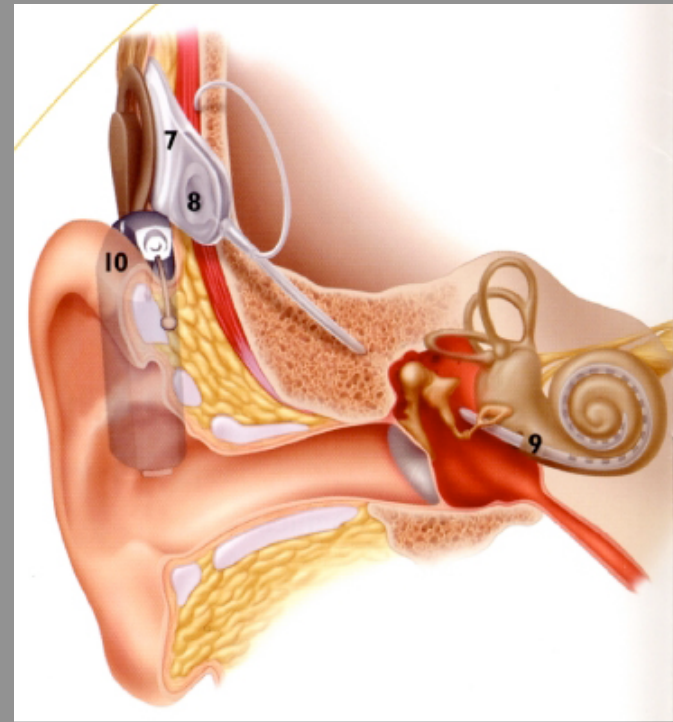
nerf auditif

Critères d'implantation cochléaire

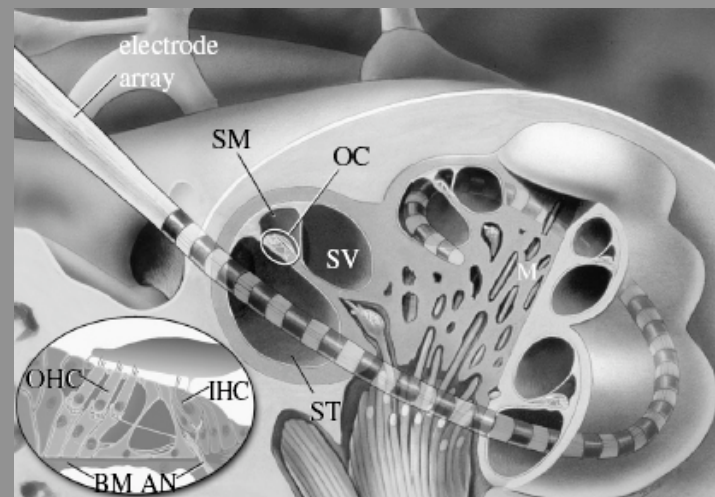


Compréhension des mots inférieure à 30% avec une prothèse externe classique

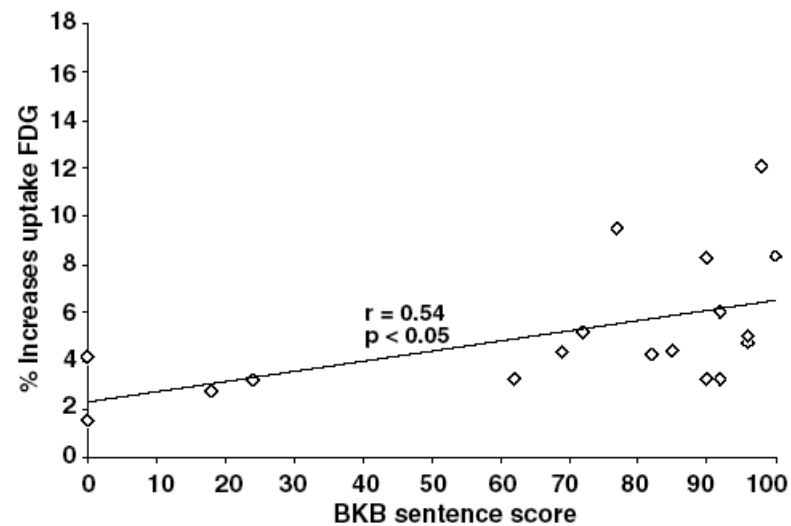
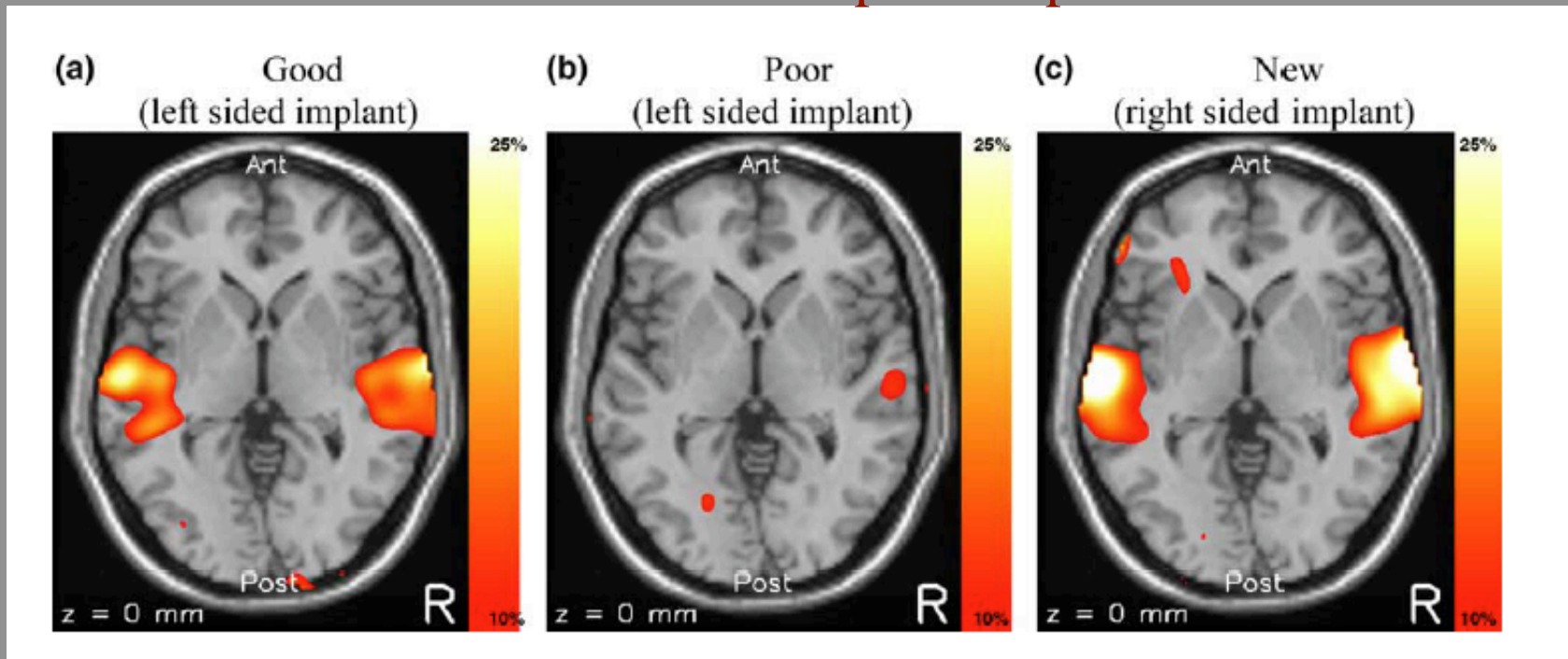
Solution for profound deafness : cochlear implant (sensori-neural prosthesis)



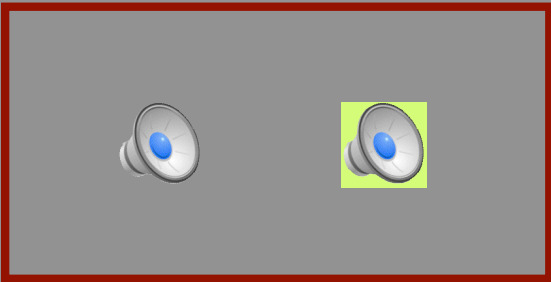
- Vocal processor
- Transduction of the acoustic signal into electrical impulses
- Stimulating electrodes



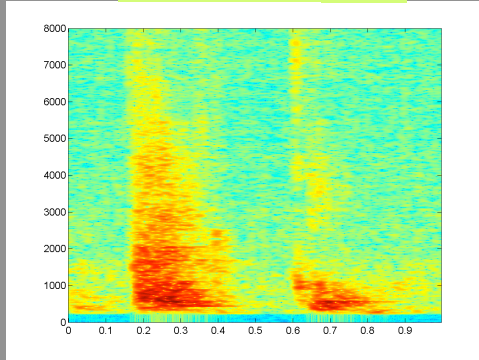
Réactivation des aires auditives par l'implant cochléaire.



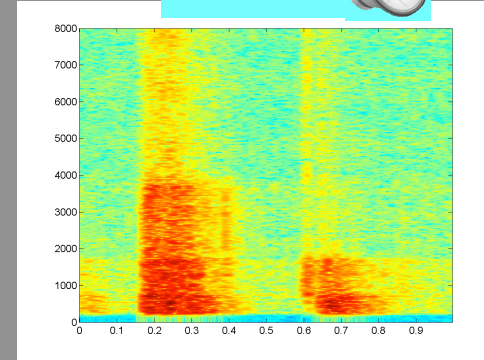
Green et al (2005)



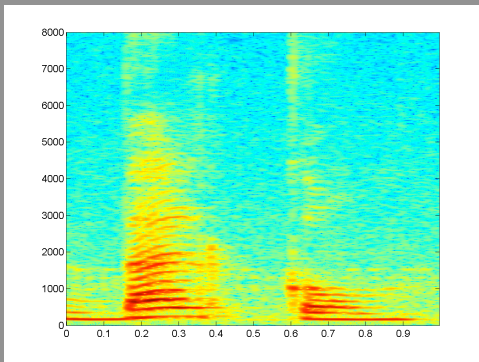
16 Bands



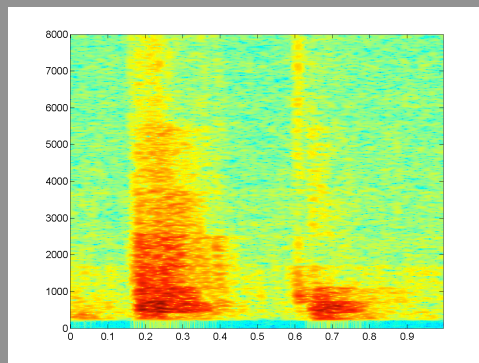
4 Bands



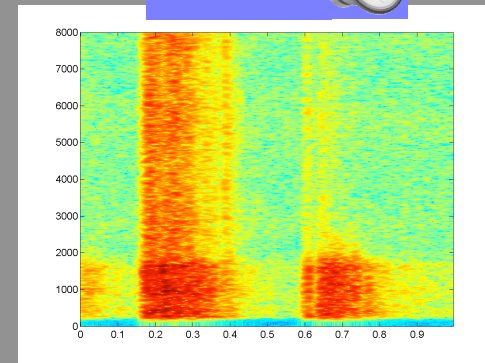
Original



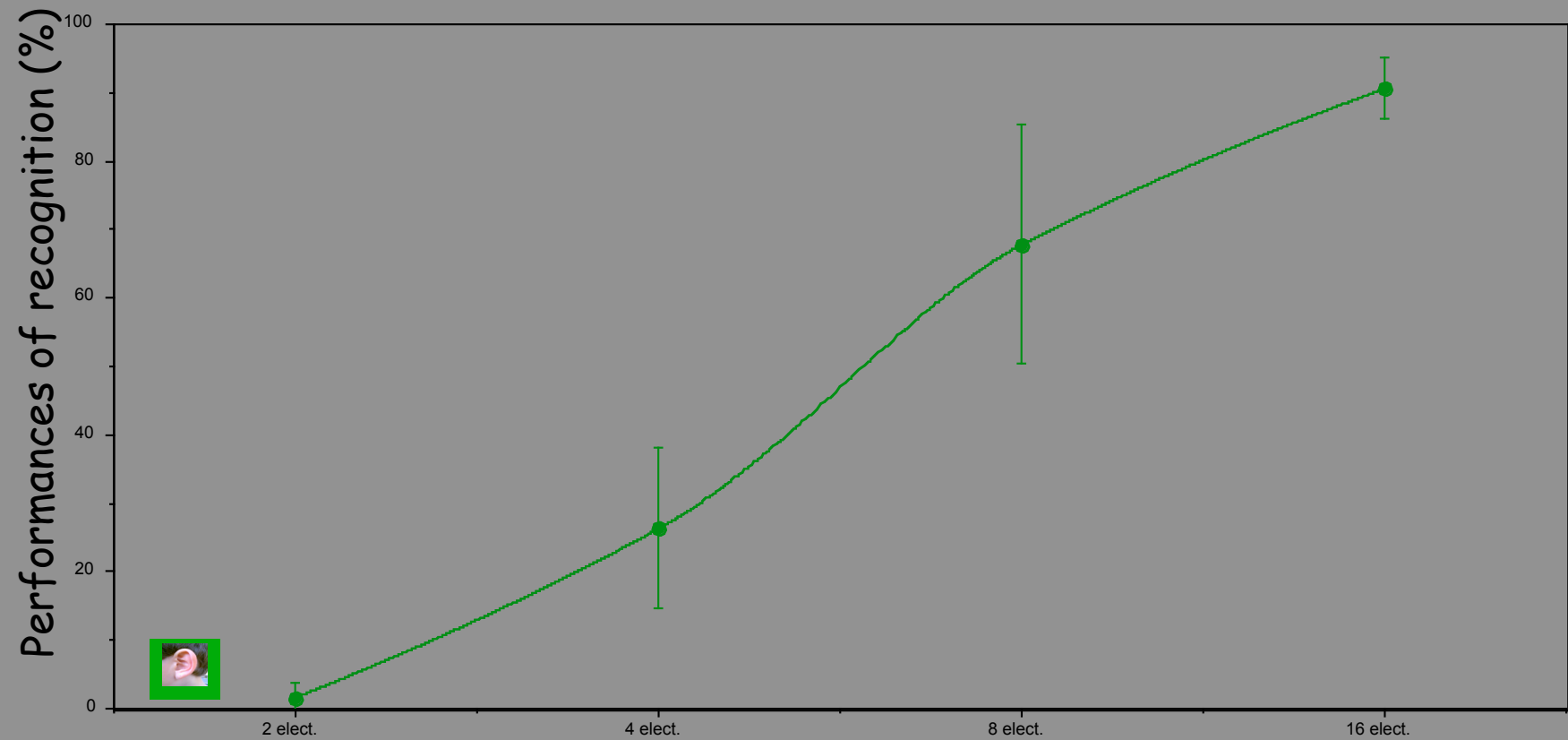
8 Bands



2 Bands

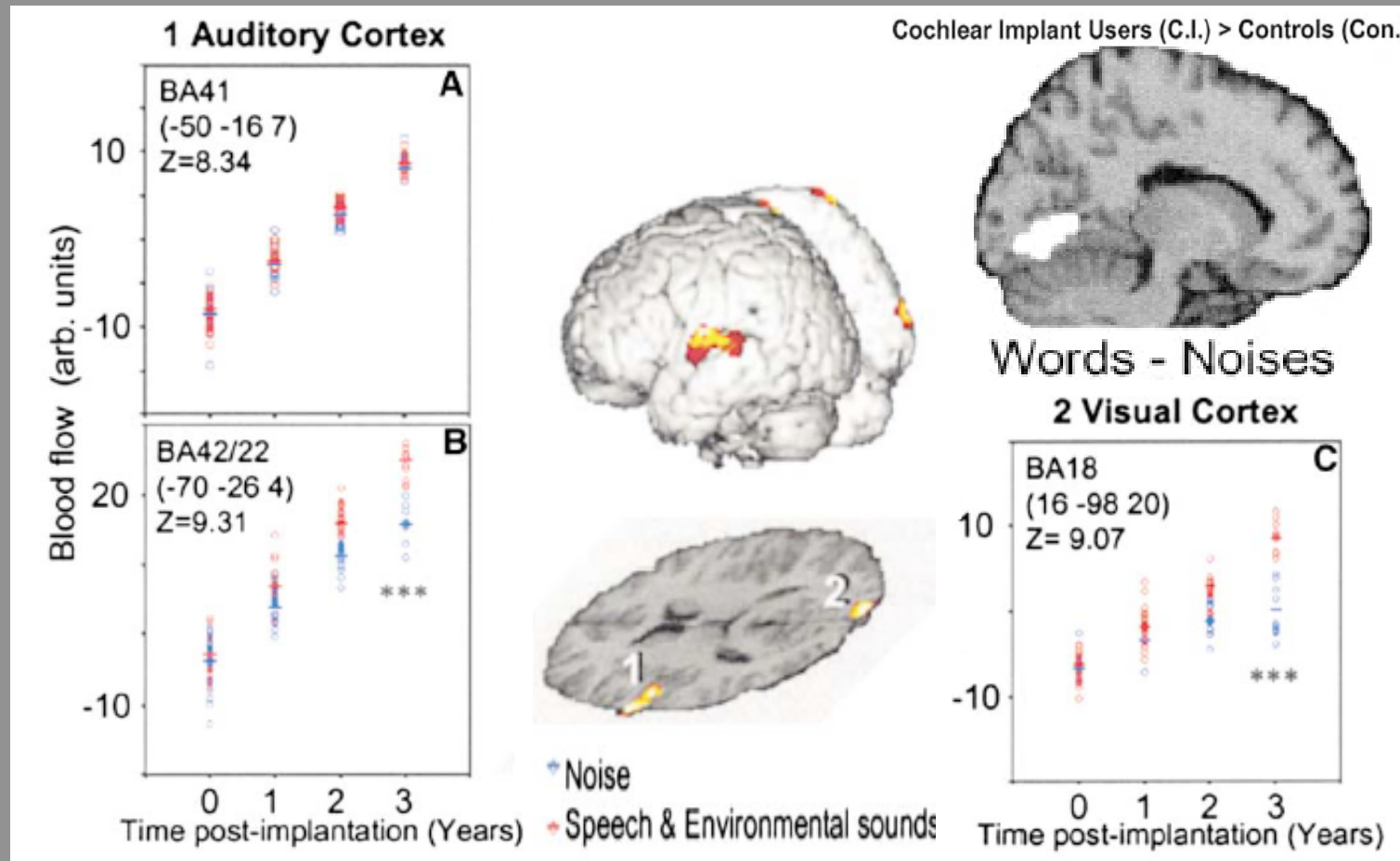


- **Words pronounced ??**
- **Gender ??**
- **Age ??**
- **Familiarity ??**



Fréquence bands (« number of electrodes »)

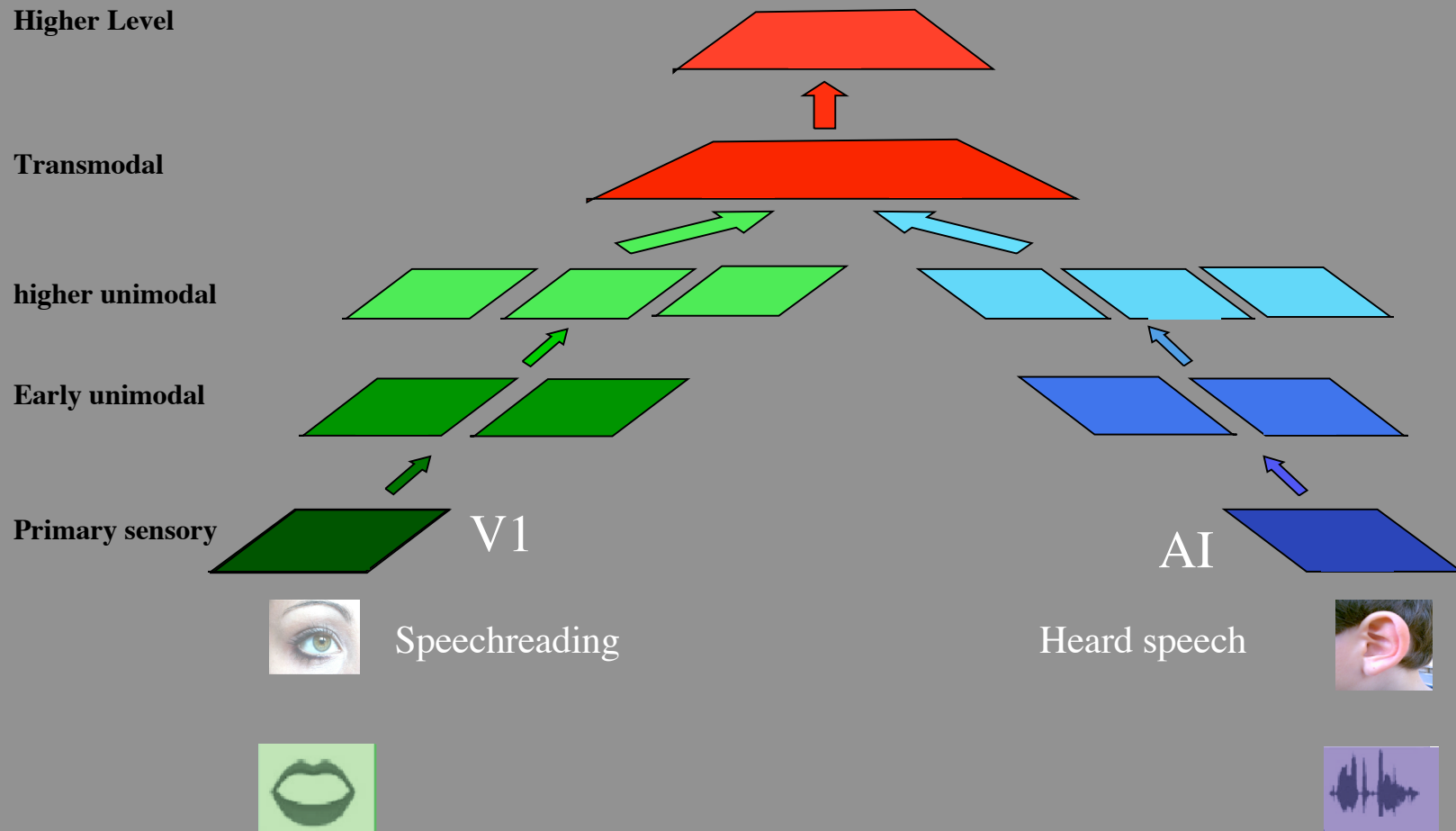
Cross-modal reorganization in cochlear implanted deaf patients ? PET study in auditory modality



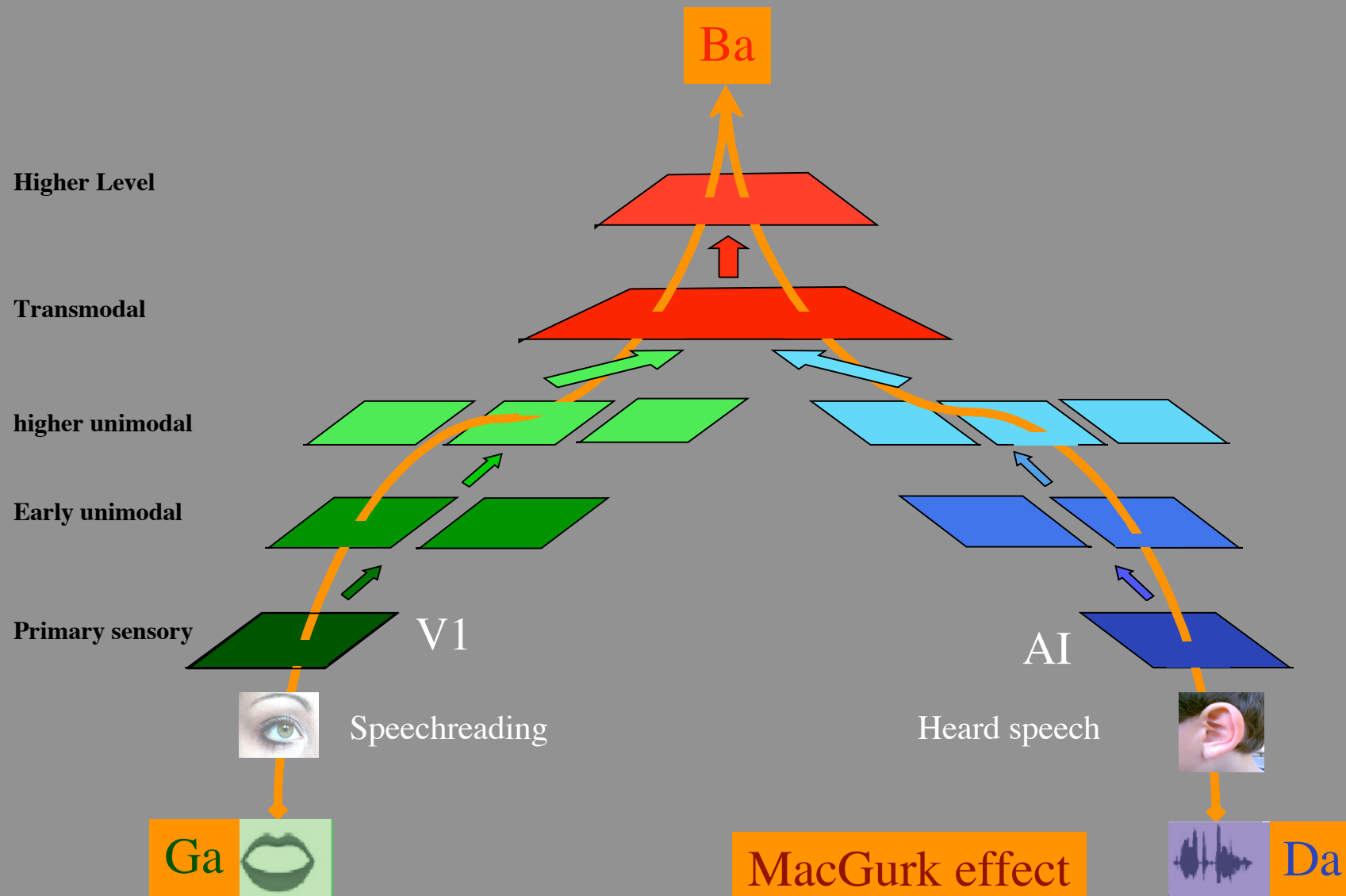
Activation of the auditory cortex Activation of the visual cortex

⇒ Synergy of visual and auditory systems during recovery of auditory functions.

Speech is a multisensory integration phenomenon



Speech is a multisensory integration phenomenon



From Bernstein et al

Behavioral and functional effects of deafness: Crossmodal compensation??

- Plastic changes that will reinforce the visual channel ?
- Reorganization of the cortical network ?

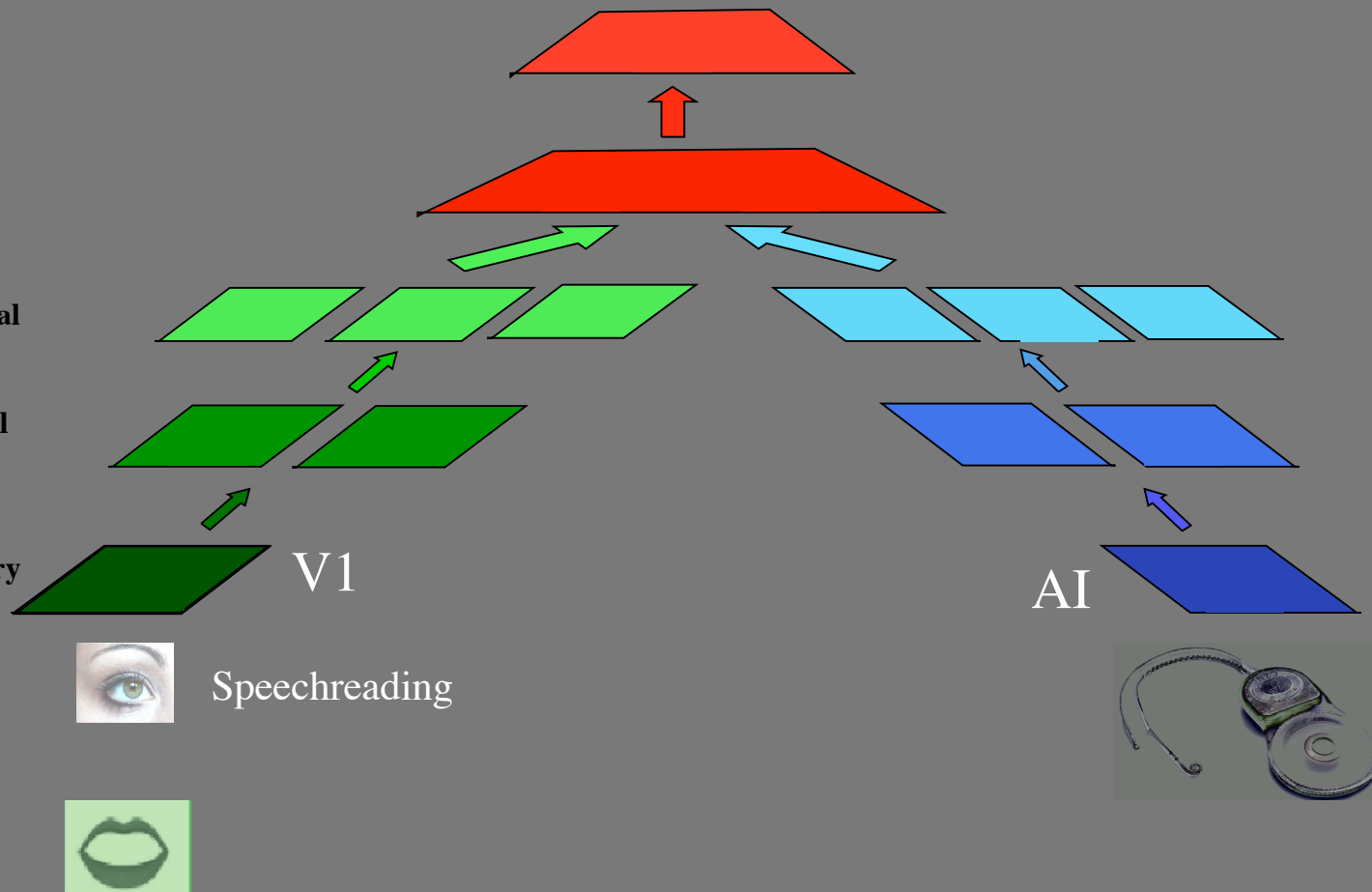
Higher Level

Transmodal

higher unimodal

Early unimodal

Primary sensory

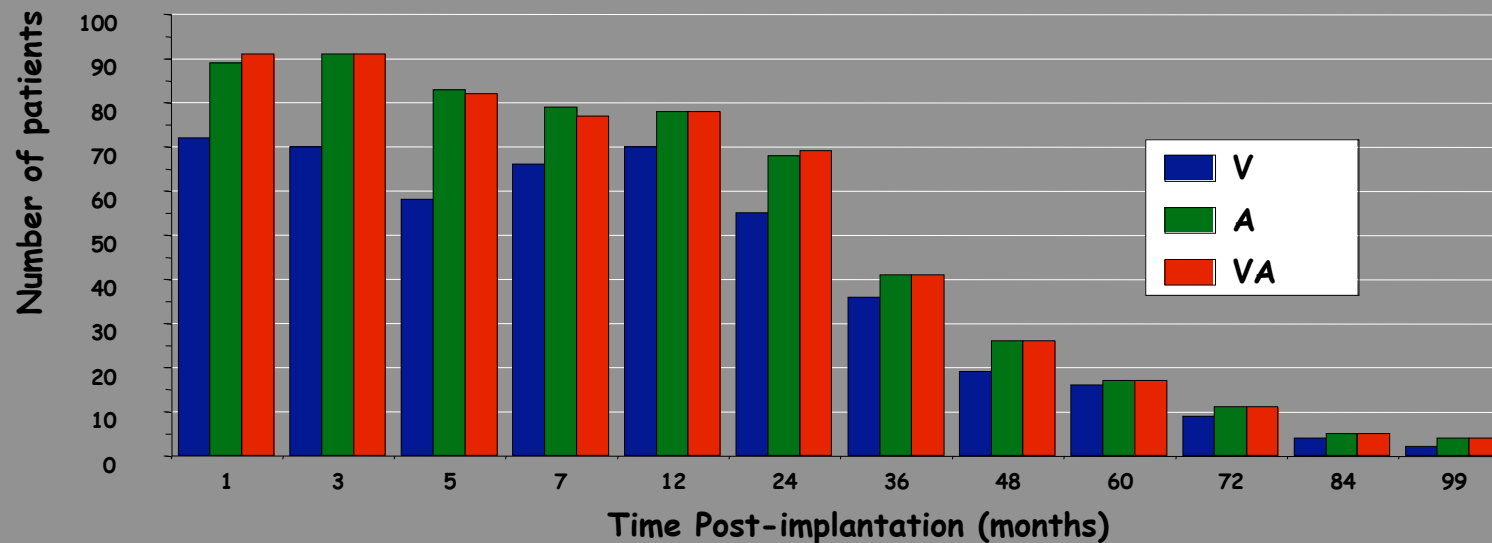


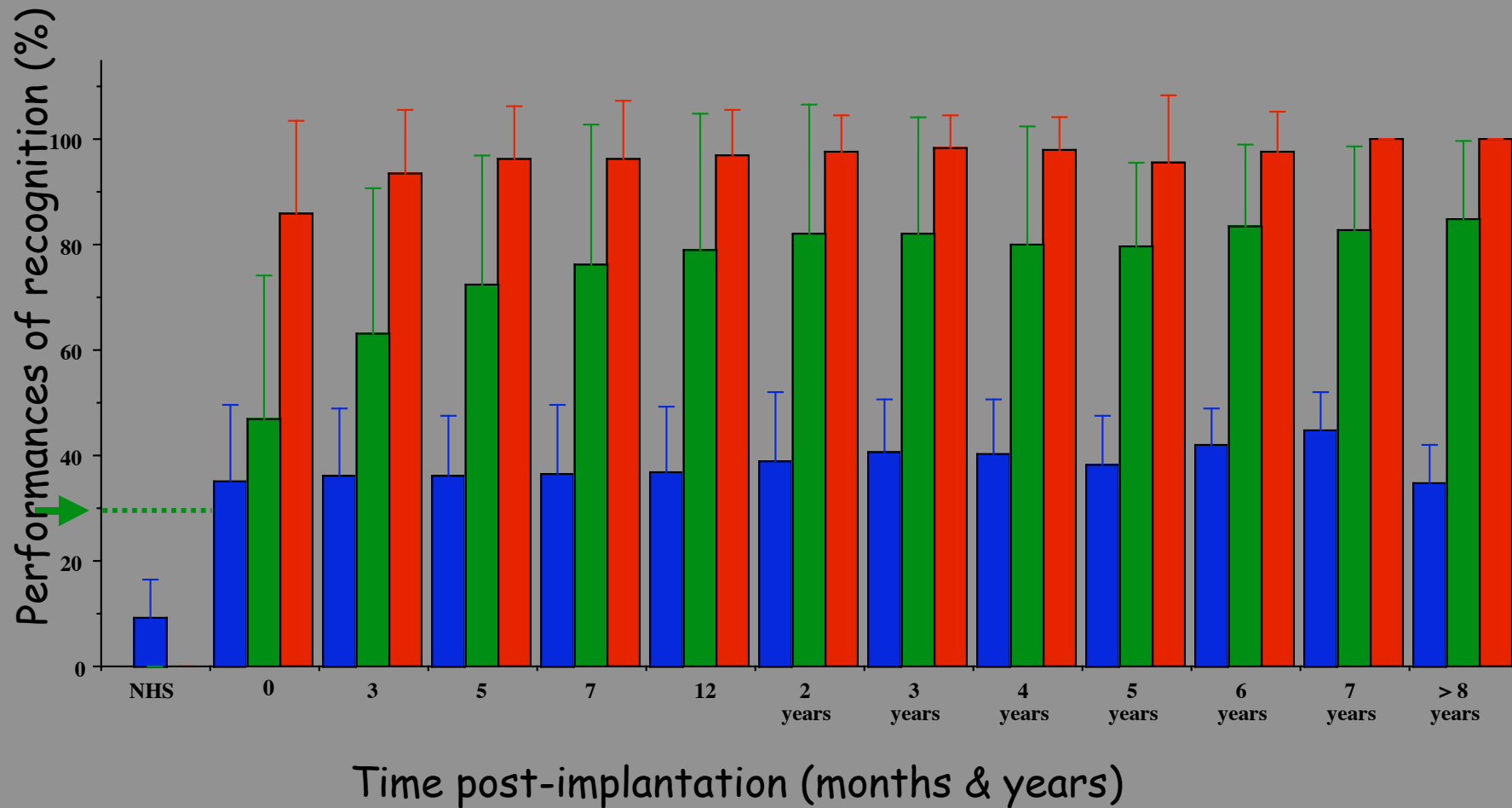
Role of visuo-auditory interactions in speech comprehension

- **Performances in deaf subjects with CI**
- **Cortical network involved**

Speech comprehension in CI subjects

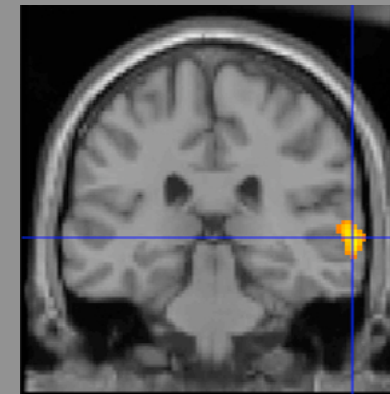
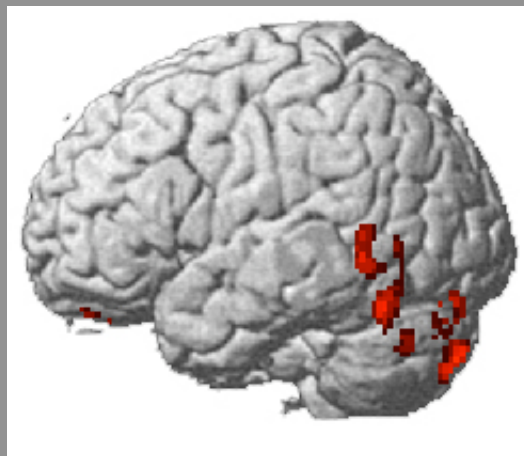
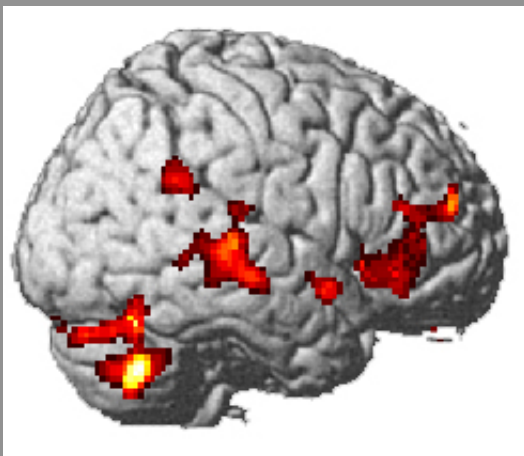
- 97 subjects
- Post-lingual deafness
- Words recognition in A, V or AV conditions
- Longitudinal follow-up over 10 years



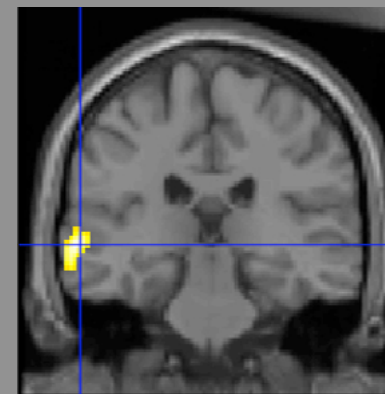
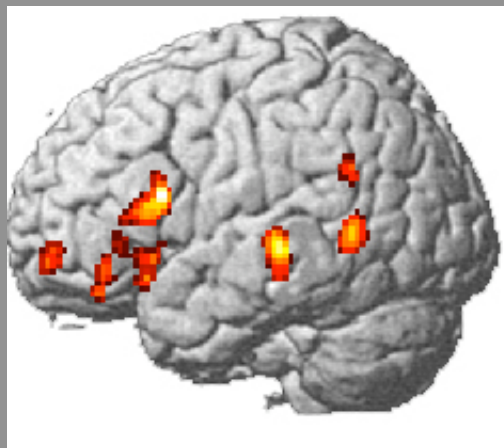
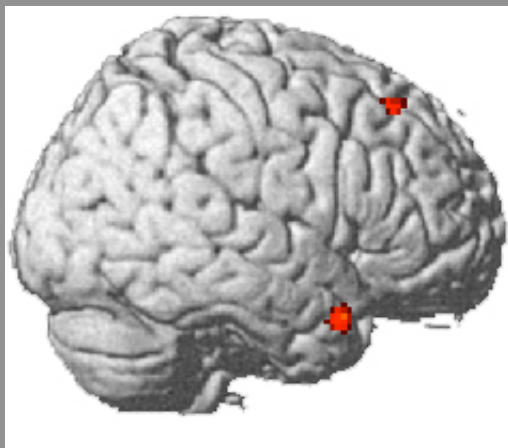


Word recognition performances in CI patients

Cochlear Implanted: activation by lip reading

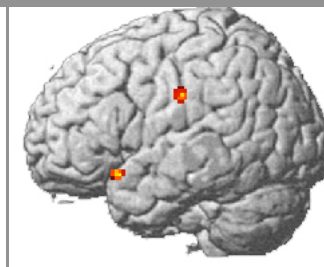
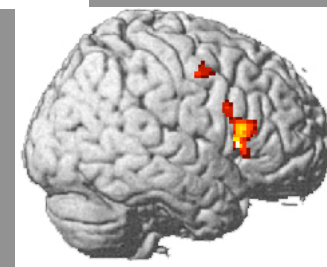


T0
n = 8

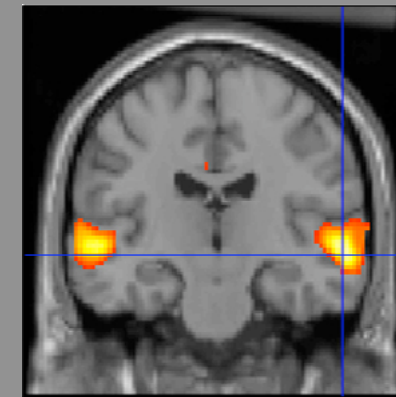
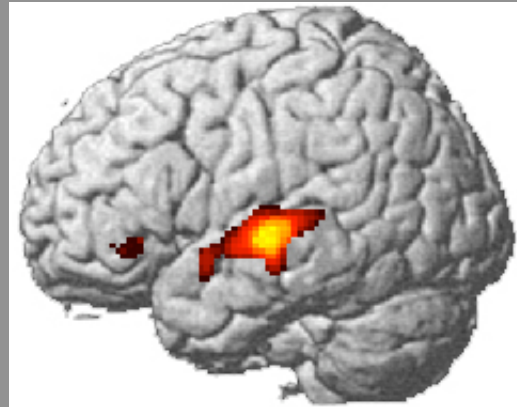
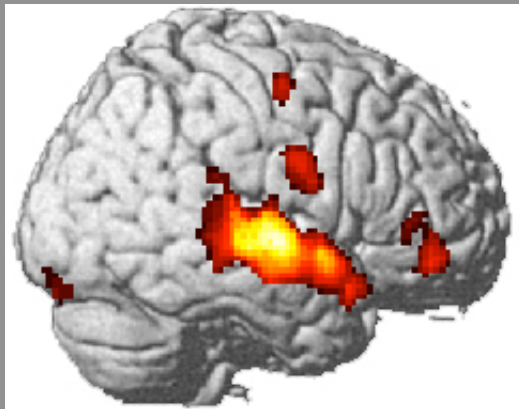


T1
n = 4

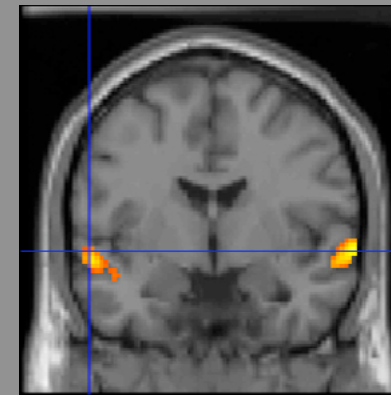
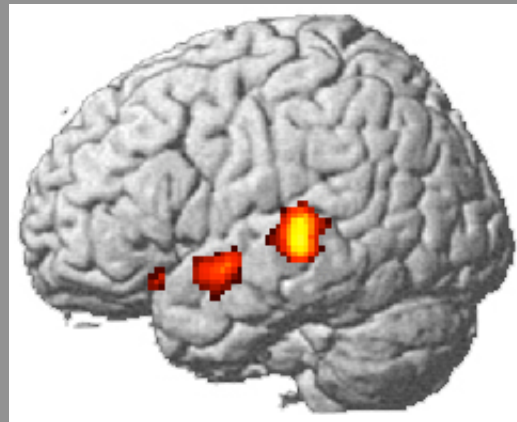
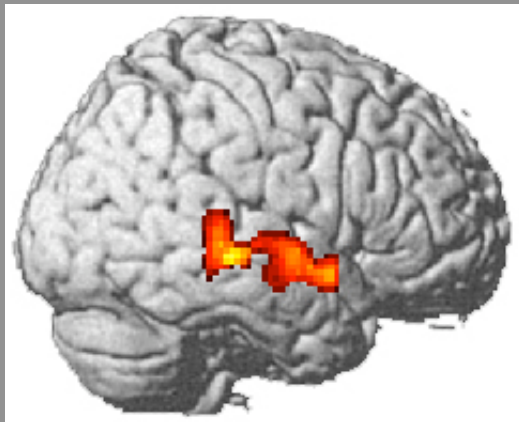
NHS



Cochlear Implanted: Visuo-auditory activation

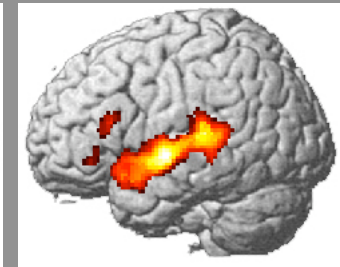
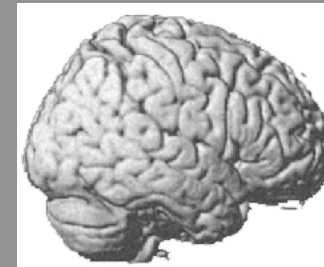


T0



T1

NHS



Conclusions

- Cross-modal compensatory mechanisms in CI patients (V & A)
- Role of visual skills in speech comprehension
- Influence of visual information in activation of auditory areas.
 - ⇒ Develop an rehabilitation strategy based on visuo-auditory integration
 - ⇒ speech comprehension in infants with CI
 - ⇒ sound localization ??
 - ⇒.....

Actors

- CHU Purpan ORL
 - Prof. O. Deguine
 - Prof. B. Fraysse
 - S. Lagleyre (interne)
 - ML Laborde (speech therapist)
 - All the patients !
- CNRS Cerco
 - J. Rouger (doctorant)
 - S. Lagleyre (DEA)
 - D. Sauvajon (M 1)
- Inserm U455
 - JF Demonet

Jean Bullier