FACTORS INFLIENCING CI CANDIDACY AND OUTCOMES

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SHANGHAI

November 30th - December 4th , 2025

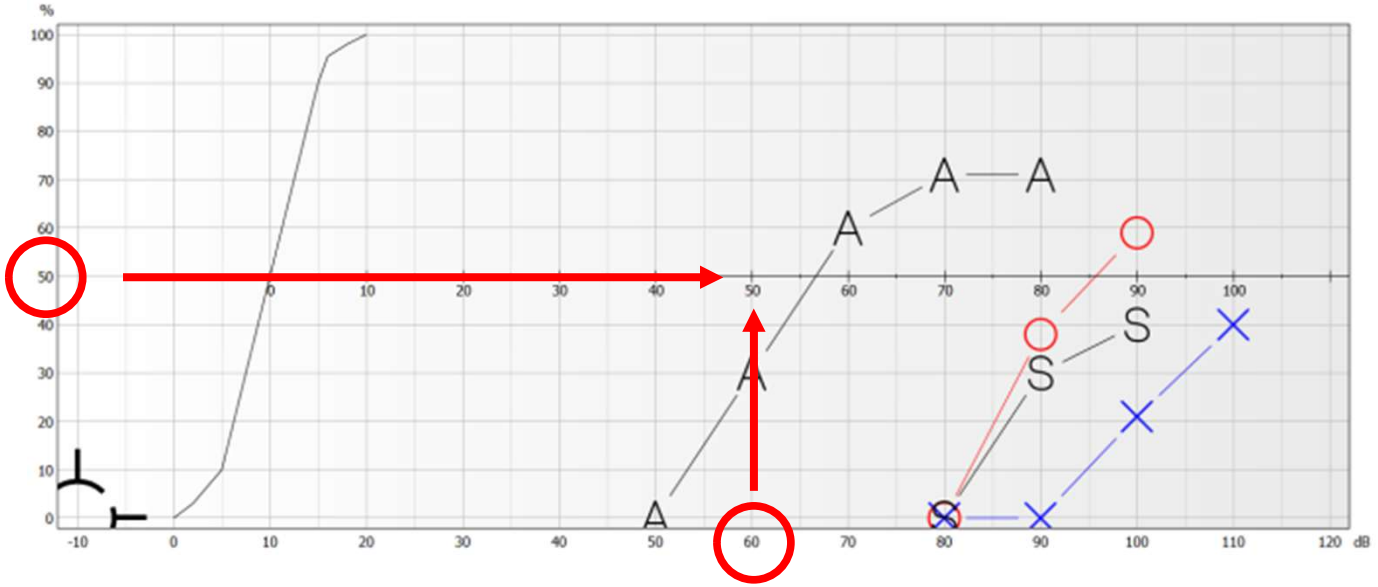
GOAL OF THE PRESENTATION

- To analysed the variation in population candidacy by using speech in noise vs speech in quiet,
- To analysed the prognosis factors of CI outcomes

TODAY POTENTIAL CANDIDATES ARE BASED ON SRT IN QUIET

HAUTE AUTORITÉ DE SANTÉ

- **Patient with word discrimination threshold (SRT) in quiet >60dB with well fitted hearing aids**



TESTING IN NOISE SEEMS MORE APPROPRIATE

- Testing in noise is considered by many authors more appropriated because :

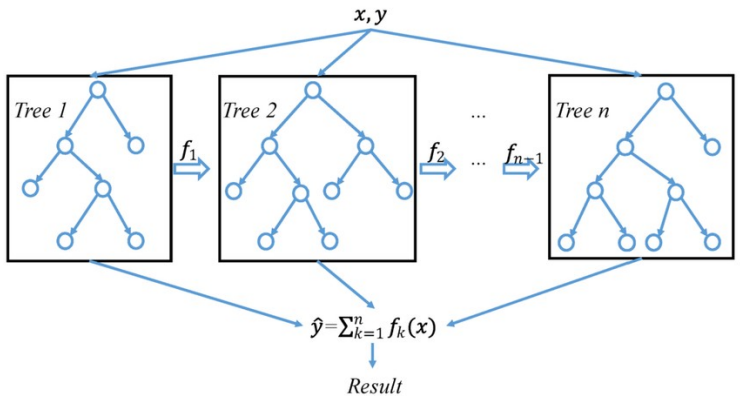
  - Difficulties in understanding speech in noise is the most common complaint of individuals with hearing loss
  - Speech in noise abilities appear to better correlated with hearing aid satisfaction
  - In the USA, 68% of CI centers are using speech in noise as candidacy criteria

QUESTIONS

- Which speech in noise criteria (SNR) should be considered as candidacy ?
- If we choise this criteria, what population be ?

DESCRIPTION OF THE POPULATION

- **Total population with hearing aids :**
  - symmetric loss : ▶ **48 298 patients**



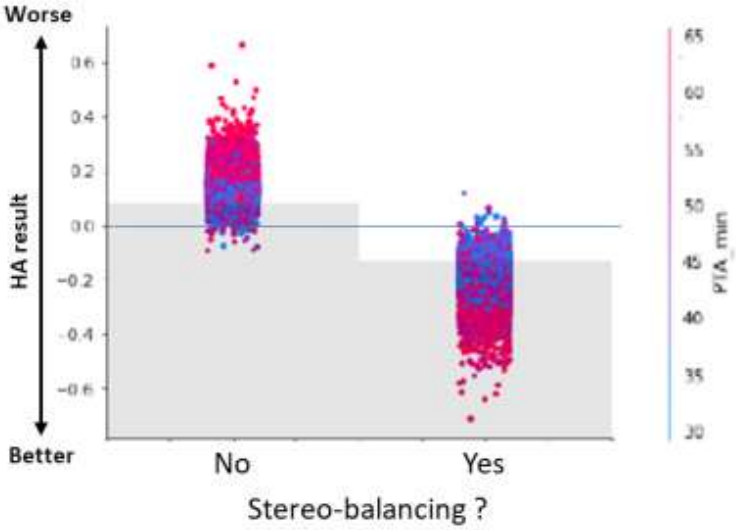
dmlc XGBoost

Data points

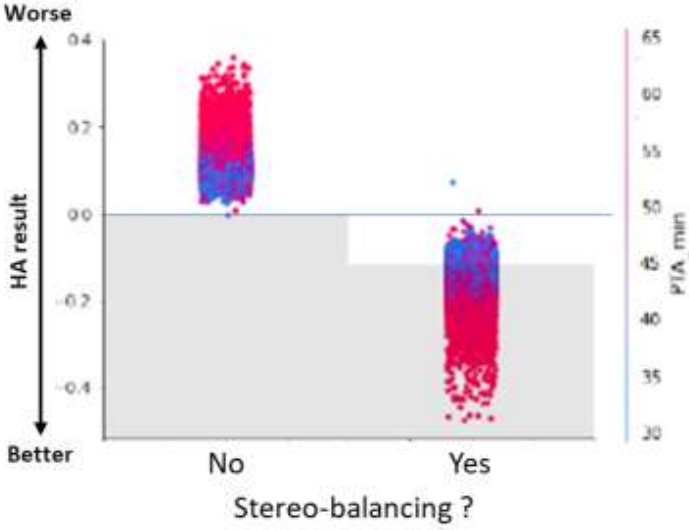
- **Patient**
  - Age
  - Sex
  - Economic Deprivation Index
- **Medical background**
  - Noise exposition
  - Tinnitus
  - Diabetes
- **Hearing**
  - PTA
  - Speech In Quiet (SPIQ)
  - Speech In Noise (SPIN)
- **Hearing aid technology**
  - HA brand (manufacturer)
  - Technological level
- **Hearing aid Settings**
  - Gain
  - Stereo-balance

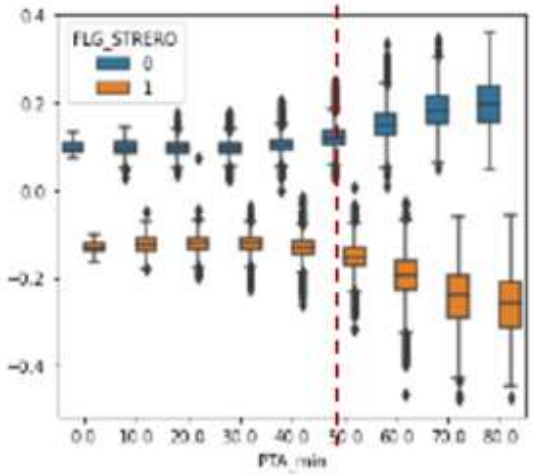
HEARING AIDS OUTCOME : IMPACT OF BINAURAL FITTING

Speech in Quiet



Speech in Noise





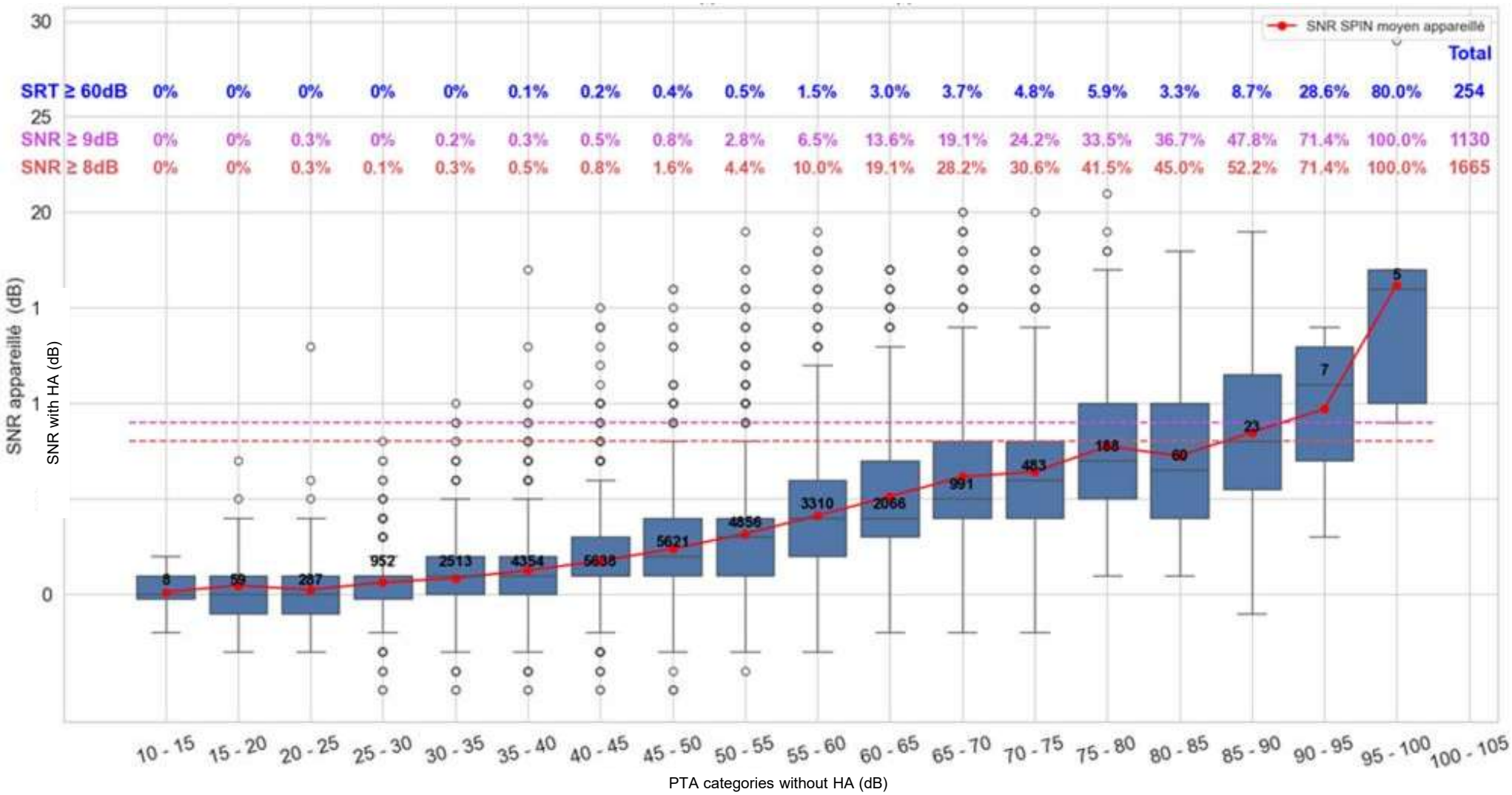
amplifon

WHAT SHOULD BE THE SNR ?

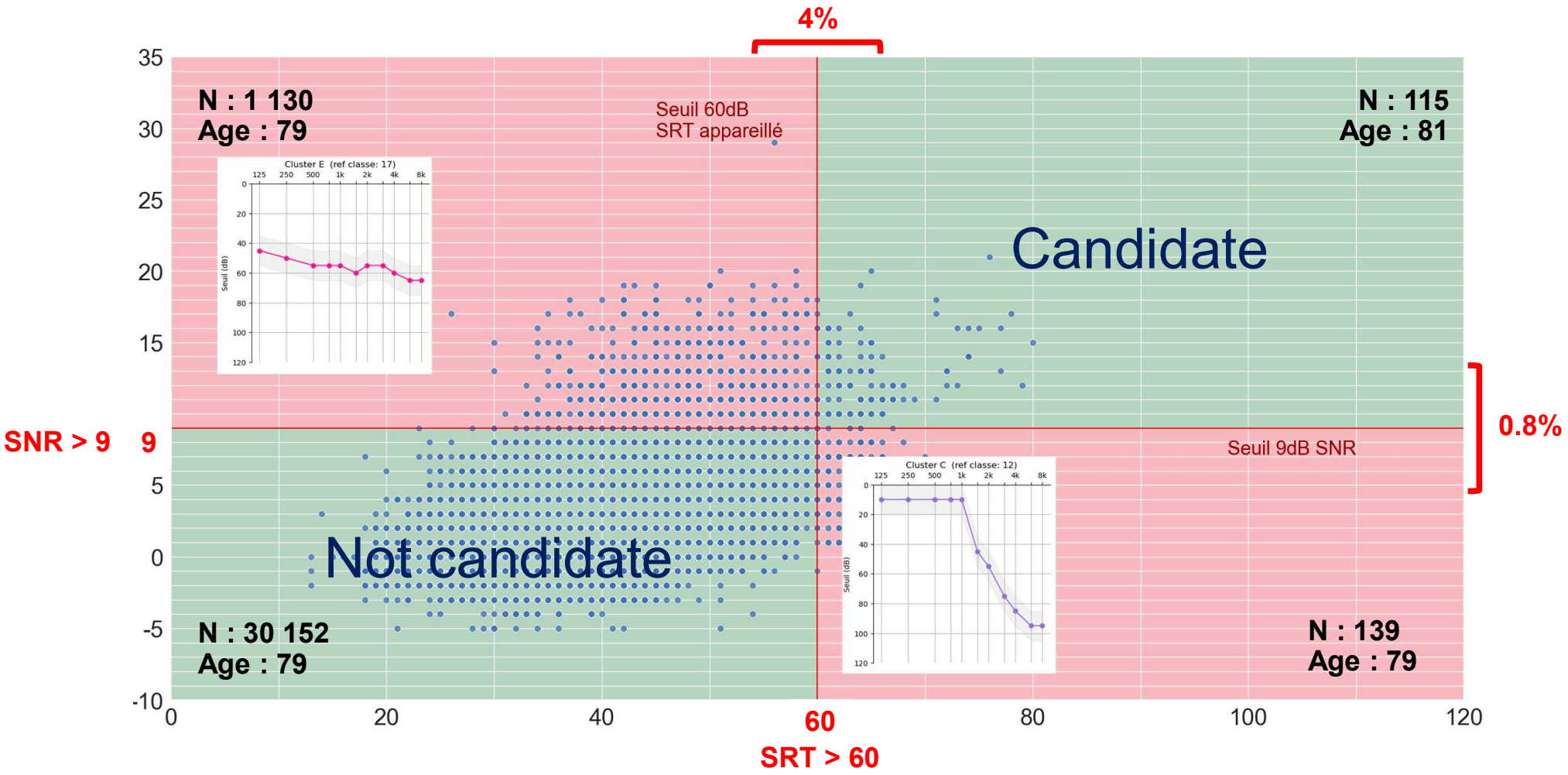
BIAP Categories		SNR SPIN with HA mean (dB)
NORMAL :	PTA ≤ 20 dB	**0.3**
MILD :	21 dB ≤ PTA ≤ 21 dB	**1.0**
MODERATE 1 :	41 dB ≤ PTA ≤ 55 dB	**2.4**
MODERATE 2 :	56 dB ≤ PTA ≤ 70 dB	**4.8**
SEVERE 1 :	71 dB ≤ PTA ≤ 80 dB	**6.9**
SEVERE 2 :	81 dB ≤ PTA ≤ 90 dB	**7.5**
PROFOUND :	91 dB ≤ PTA	**10.9**

- In this cohort, patient candidate for *CI in quiet* SRT>60dB with HA, have an **SNR 8.6dB HA**

COCHLEAR IMPLANT CANDIDACY QUIET vs NOISE

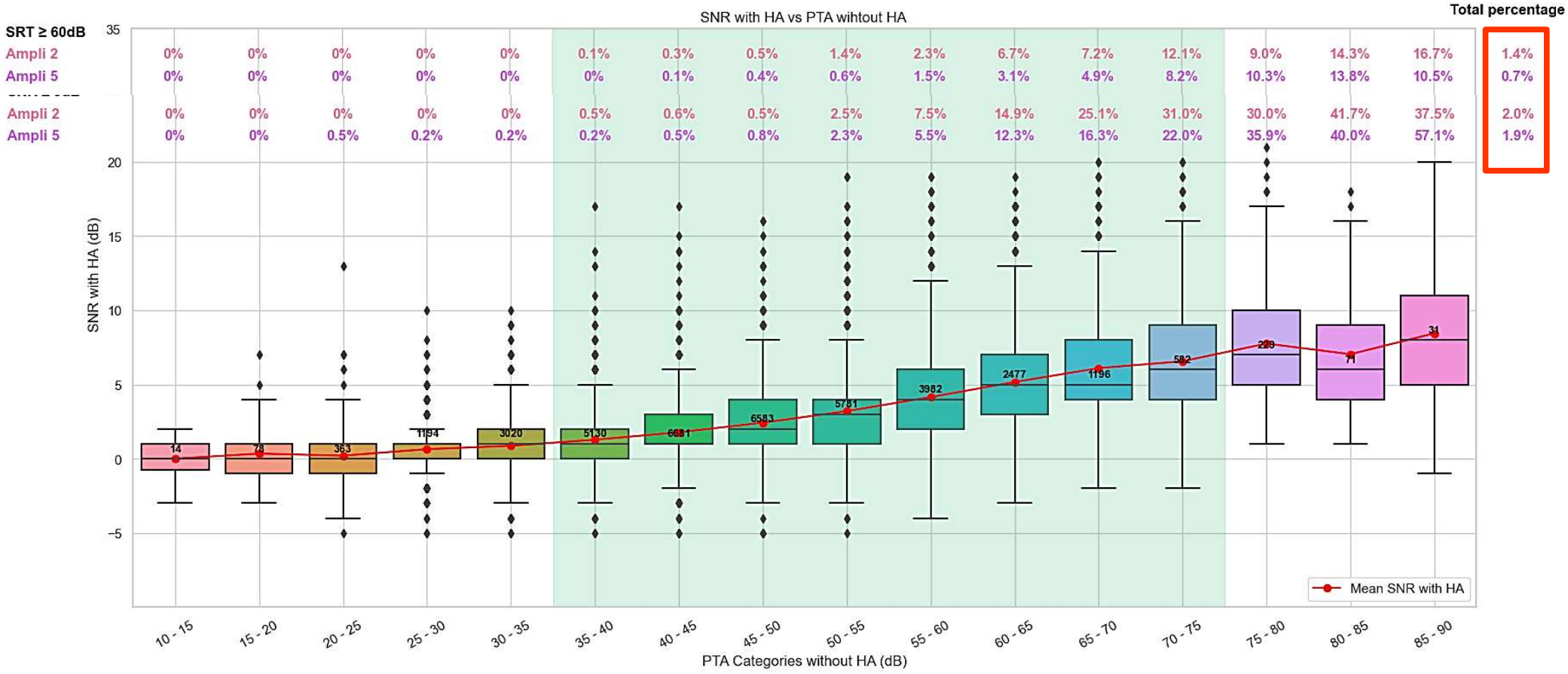


COMPARISON QUIET vs NOISE FOR CI CANDIDACY



IMPACT OF HEARING AID TECHNOLOGY PREMIUM vs BASIC HA

PTA SNR amplisolution



Prognosis factors of CI outcomes

FACTORS CONSIDERED

1. **Biographic factors**
   - Age at implantation
   - Etiology
   - Duration of hearing loss

   } *Patient related*

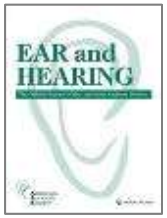
2. **Anatomical and surgical factors**
   - Insertion depth of apical electrodes
   - Scala location

   } *Insertion technique*

- **Linguistic and neurocognitive skills**

} *Personalized auditory rehabilitation*

POPULATION



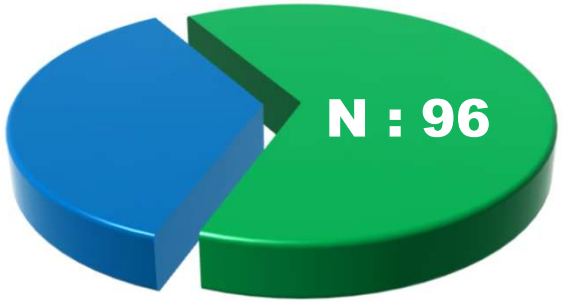
Early Sentence Recognition in Adult Cochlear Implant Users

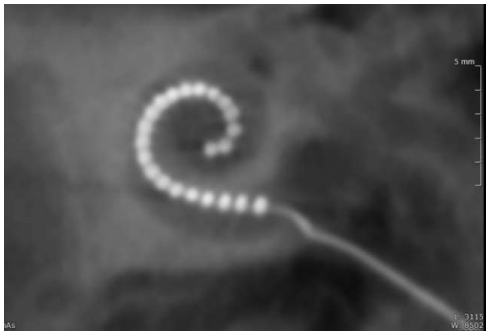
Chris J. James,[1,2] Chadlia Karoui,[1,3] Marie-Laurence Laborde,[1] Benoît Lepage,[4] Charles-Édouard Molinier,[1] Marjorie Tartayre,[1] Bernard Escudé,[5] Olivier Deguine,[1,3] Mathieu Marx,[1,3] and Bernard Fraysse[1]

(Ear & Hearing 2019;40;905–917)

Inclusion

- 118 adults with unilateral CI and profound HL at least one year follow-up and receiving the same aural rehabilitation program





Cone Beam / CT-Scan

Study design

- The percentage of variance in sentence scores explained by each factor and the quantitative effect on scores

❶ BIOGRAPHIC FACTORS

Early Sentence Recognition in Adult Cochlear Implant Users

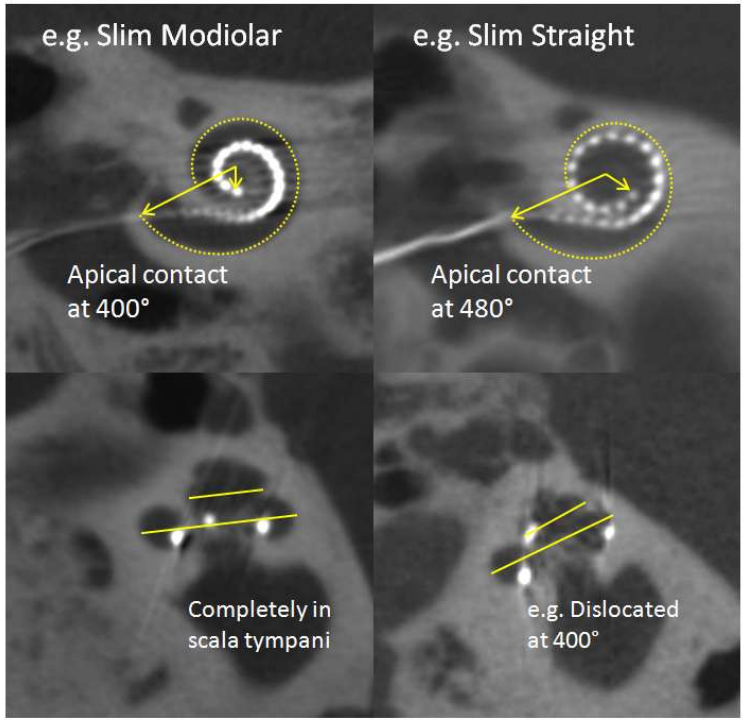
Chris J. James,[1,2] Chadlia Karoui,[1,3] Marie-Laurence Laborde,[1] Benoît Lepage,[4] Charles-Édouard Molinier,[1] Marjorie Tartayre,[1] Bernard Escudé,[5] Olivier Deguine,[1,3] Mathieu Marx,[1,3] and Bernard Fraysse[1]

(Ear & Hearing 2019;40;905–917)

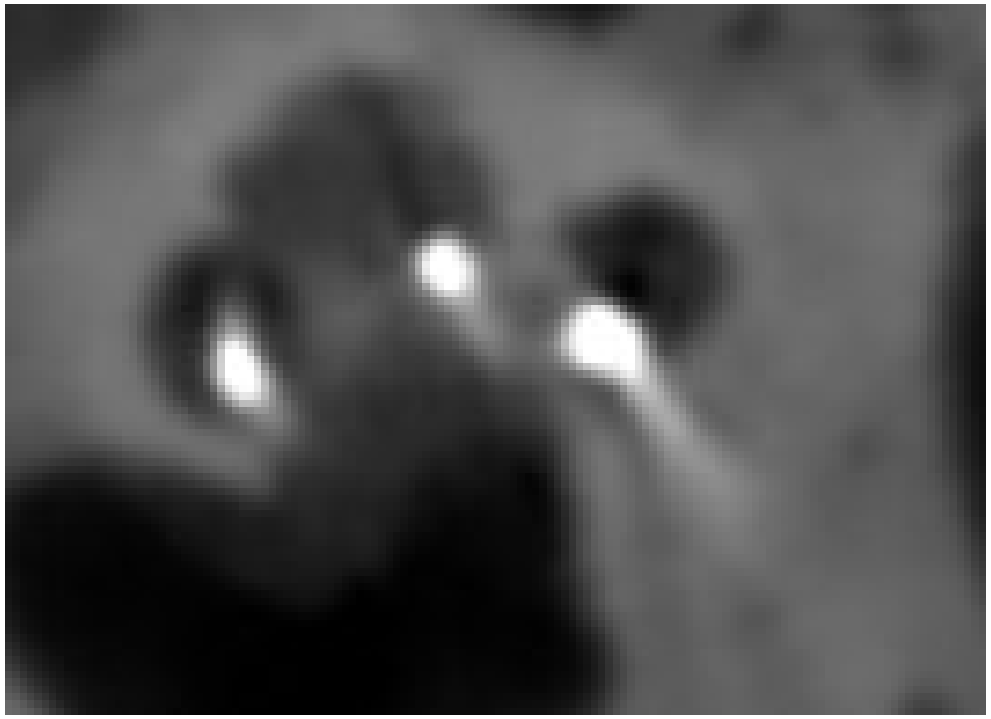
- Age at implantation : **NS**
- Duration of deafness : 9 to 12% total variance
  (*0.46 pts per year of profound HL)*
- Etiologies : 20 to 30% total variance
  (*Chronic otitis, Meniere's disease)*

❷ ANATOMICAL AND SURGICAL FACTORS BASED ON POSTOPERATIVE IMAGING

1 Insertion depth



2 Scalar location



In vivo CT images: Professor Tobias Struffert, University of Erlangen.

THE EFFECT OF INSERTION DEPTH ON AUDITORY OUTCOMES

Early Sentence Recognition in Adult Cochlear Implant Users

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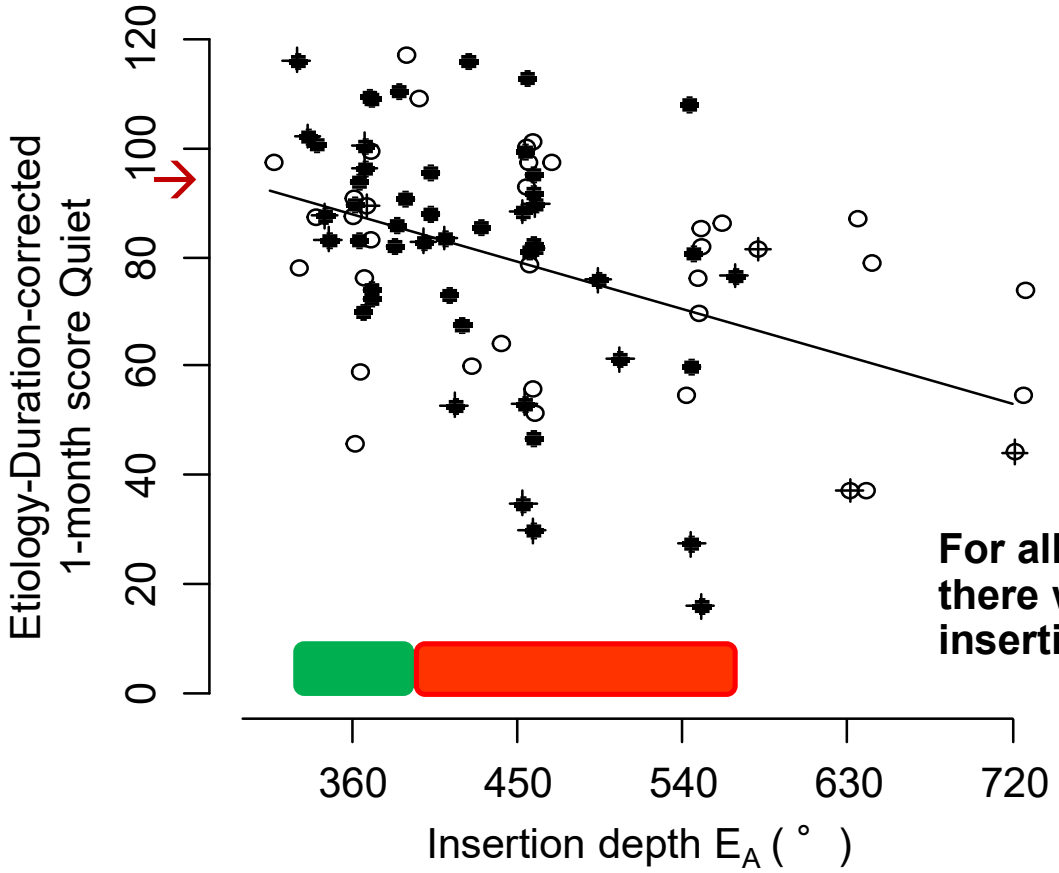


- Nucleus Perimodiolar
- Nucleus AB MED-EL } Straight designs

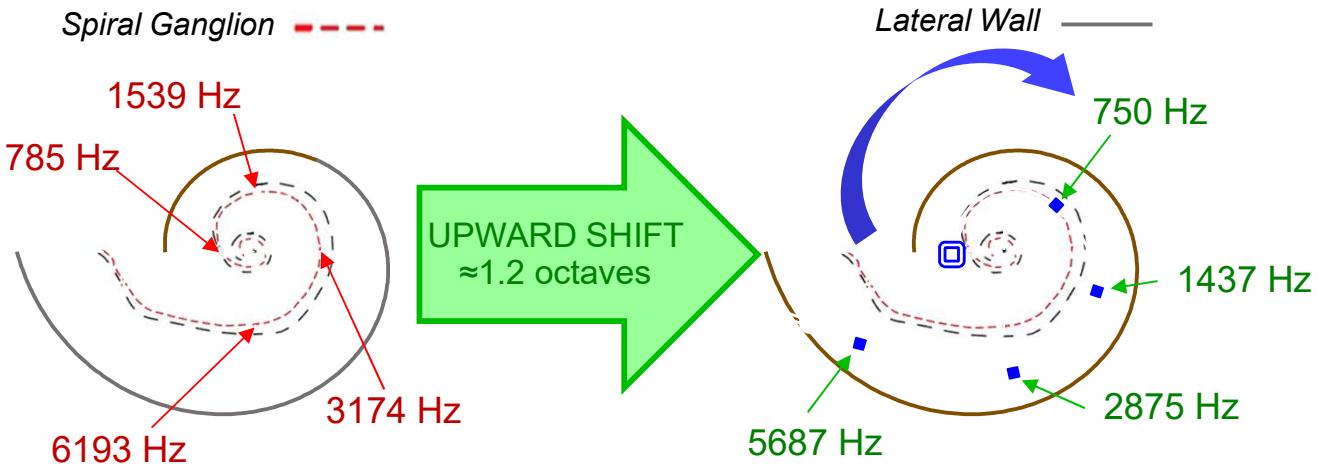
+ ST→SV or SV

For all electrodes and Contour electrodes alone there was a negative correlation between insertion depth and auditory outcomes

9% of variance, p<0.001

WHY WOULD SCORES DECREASE WITH INCREASING INSERTION DEPTH ?

- Because frequency allocation mismatches
- Moderate shifts may be easily accomodated but larger shifts > 1,5 octave may affect auditory performance and the adaptation process take more time *(e.g. Li et al., 2009)*



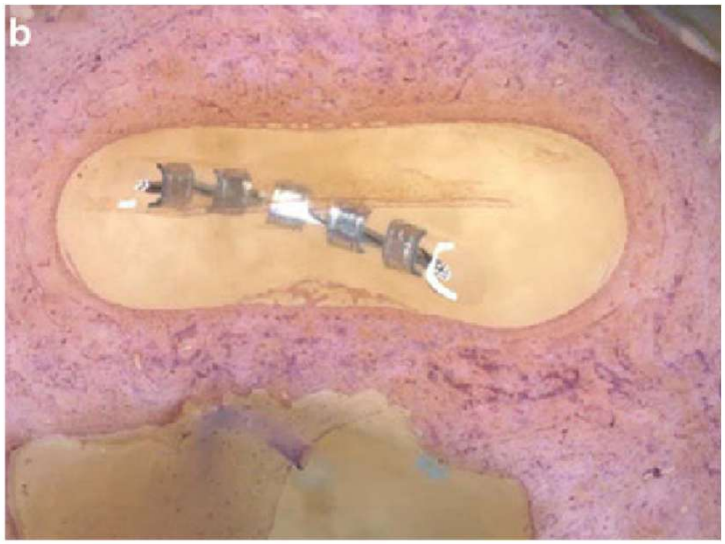
Mean spiral ganglion frequencies (Stakhovskaya et al, 2007)

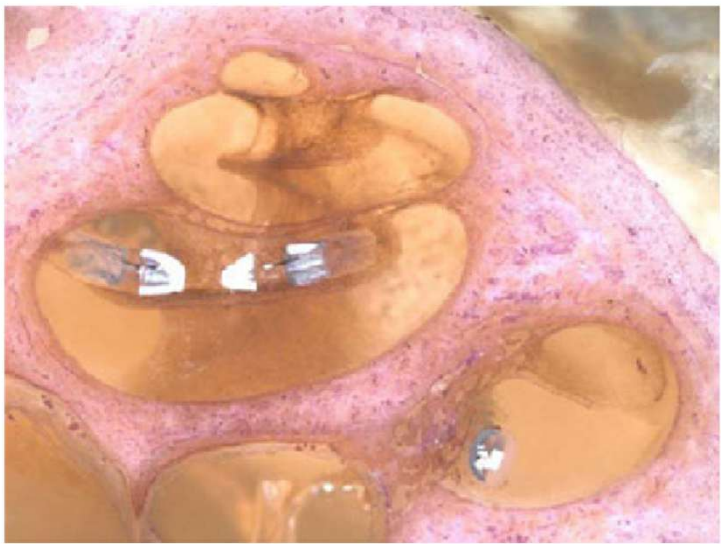
Matched sound-processor frequency to electrode allocation

SCALAR DISLOCATION IMPACTS AUDITORY OUTCOMES

(Ear & Hearing 2019;40;905–917)

- **In our study the scala dislocation reduced scores by 12 - 25 pts at one month *($p<0.01$, $r^2=14\%$)* *in perimodiolar electrodes***

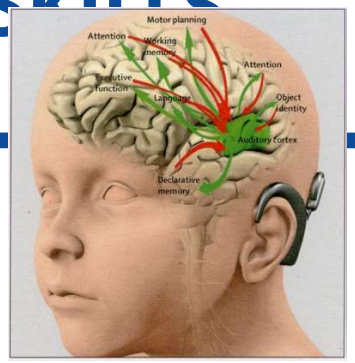




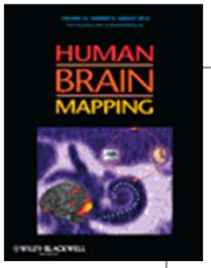
VARIANCE OF PERIPHERAL FACTORS ON OUTCOMES

	In noise	In quiet
Etiology	0.34***	0.25**
Duration of deafness per year	0.06* per year	0.08* per year
Insertion length per degree	0.09***	0.08**
Proportion of electrodes in the scala tympani	0.14**	0.13**
Total impact of peripheral factors	**41%**	**49%**

NEUROCOGNITIVE AND LINGUISTIC SKILLS



- In our study, approximately 50 % of the variance at 1 month cannot be explained by auditory peripheral factors
- Speech discrimination in degraded condition to may be compensated by neurocognitive and linguistic skills
- The evolution of crossmodal plasticity is one of the underlying processes of compensatory mechanisms

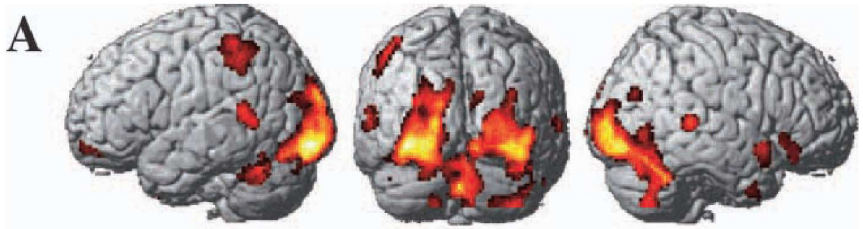


◆ Human Brain Mapping 33:1929–1940 (2012) ◆

Evolution of Crossmodal Reorganization of the Voice Area in Cochlear-Implanted Deaf Patients

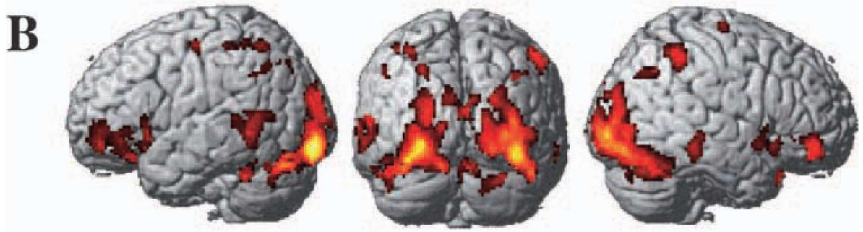
Julien Rouger,[1] Sébastien Lagleyre,[2] Jean-François Démonet,[3]
Bernard Fraysse,[2] Olivier Deguine,[1,2] and Pascal Barone[1]*

- We studied the dynamics of reversed crossmodal plasticity by TEP Brain imaging during auditory speech tracking



Cochlear Implanted patients at T0 (n = 10)

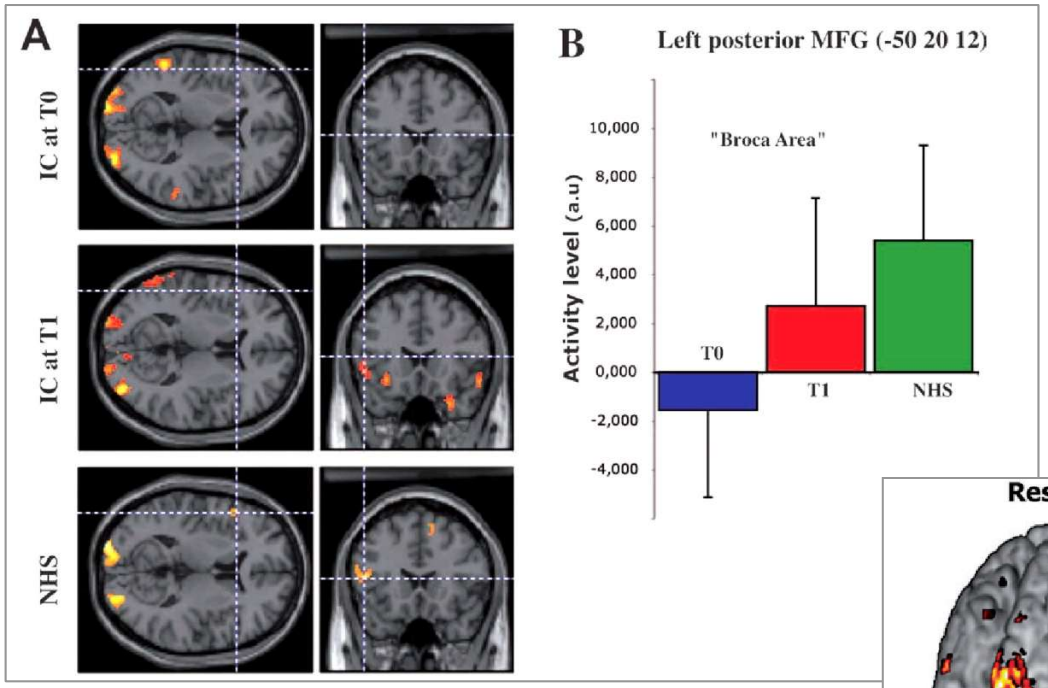
Time of activation



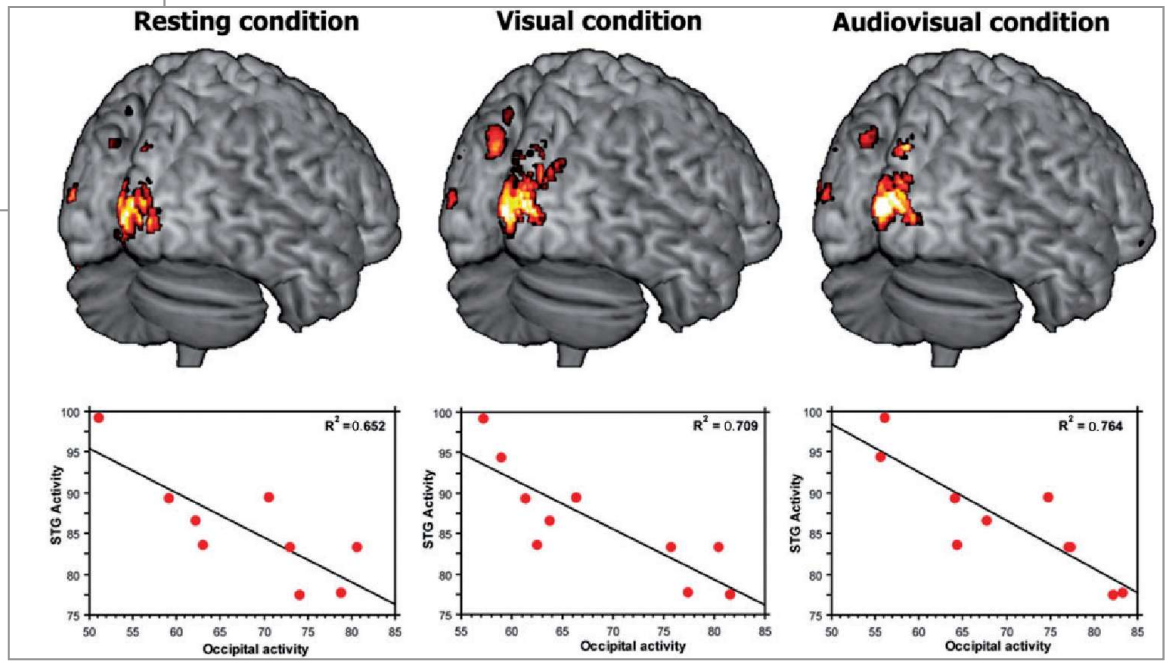
Cochlear Implanted patients at T1 (n = 9)

Patient reached 60% correct speech recognition

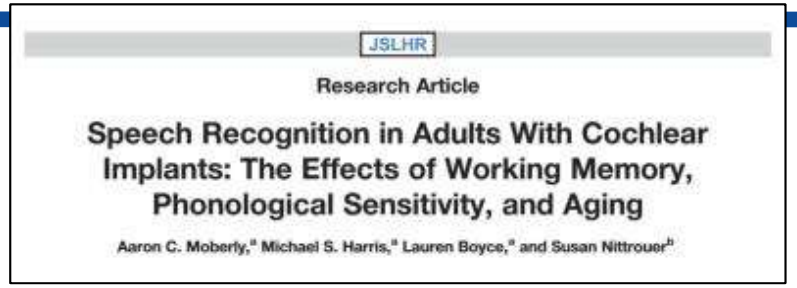
- **Auditory stimulation determined a reactivation of auditory cortical areas but also a crossmodal reorganization of the cortical visual network**



- **Clear correlation between individual visual and auditory brain activity and auditory outcomes**



CONSIDERING CORTICAL PLASTICITY


JSLHR

Research Article

Speech Recognition in Adults With Cochlear Implants: The Effects of Working Memory, Phonological Sensitivity, and Aging

Aaron C. Moberly,[a] Michael S. Harris,[a] Lauren Boyce,[a] and Susan Nittrouer[b]

- Optimization of the rehabilitation must take into account the level of :

❶ Phonemic sensitivity and lexical knowledge

❷ Cognitive factors

→ Speed of processing

→ Working memory and attention

→ Executive function

One month results → Normal performer → Conventional rehabilitation

Poor performer

Auditory evaluation on objective method

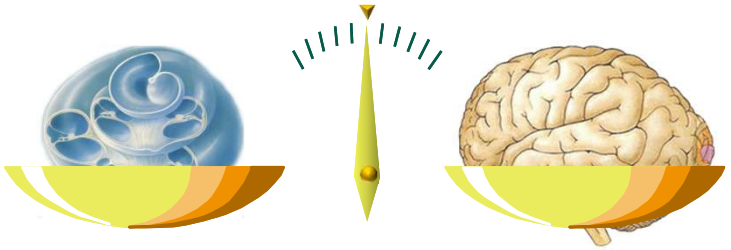
- Frequency allocation
- Scalar location

} X-Ray

- Speed of stimulation refractory period
- Channel selectivity spread of excitation

Working memory and phonological sensitivity evaluation

Personalized auditory rehabilitation



« Bottom up » approach

« Top down » approach

CONCLUSION

- Counseling patients with realistic expectations and take into account the patient's goals (GAS)
- Electrode insertion should avoid dislocation and be adapted to the tonotopic organization
- Develop personalized rehabilitation programs and material based on early outcomes and targeted on specific weaknesses

Thank you for your attention

PREDICTIVE MODEL OF AUDITORY PERFORMANCE

- Assume that we reduce negative factors that we can control
  - Avoid scala dislocation with an **atraumatic perimodiolar array**
  - Target the insertion depth to **~360˚**

- From our study we derived a mathematical model for 1-month sentence scores based on biographic factors

Score ≈ 90 – 0.5/yr HL – (if etiologies)

POPULATION

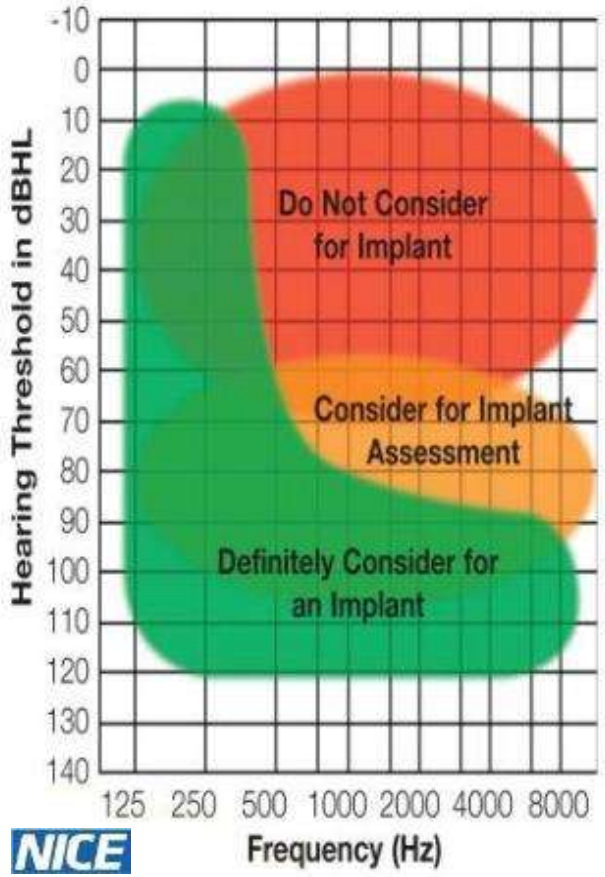
48 298 symmetric

BIAP	NUMBER	CANDIDATES CI	PERCENTAGE
NORMAL	84	0	0.00%
MILD	10 960	6	**0.05%**
MODERATE 1	24 187	95	**0.39%**
MODERATE 2	11 384	334	**2.93%**
SEVERE 1	1 433	116	8.09%
SEVERE 2	193	25	12.95%
PROFOUND	57	20	35.09%
TOTAL	**48 298**	**596**	**1.23%**

In this cohort with 80% of patients meeting the implantation criteria were not reffered

IDENTIFICATION OF POTENTIAL CANDIDATES FOR CI

Living guideline




frontiers | Frontiers in Public Health

TYPE Brief Research Report
PUBLISHED 15 December 2023
DOI 10.3389/fpubh.2023.1272437

Strategies for the implementation of the living guidelines for cochlear implantation in adults

Ángel Ramos-Macías[1], Leo De Raeve[2]*, Meredith Holcomb[3], Ella Connor[4], Aiya Taylor[5], Irene Deltetto[4] and Colman Taylor[4,5]

- **PTA (500-1 000-2 000)> 60 dBHL should be referred to a cochlear implant assesment**

IDENTIFICATION OF POTENTIAL CANDIDATES
(PTA>60dB - SRT>60dB)

48 298 symmetric

- Patient with bilateral symmetric hearing loss and all data available

	Candidate	Non Candidate	Total
PTA > 60dB SRT>60dB	390 (129)	7 052 (2 378)	7 442 (2 507)
PTA ≤ 60dB SRT<60dB	206 (70)	40 650 (2 937)	40 856 (3 007)
Total	**596** **(199)**	**47 702** **(5 315)**	**48 298** **(5 514)**

Sensitivity : 64%
Sensitivity : 64,8%

Specificity : 14%
Specificity : 44,7%

TAKE HOME MESSAGE/POTENTIAL CANDIDATES

- In routine assessment PTA as a low specificity it should be correlated to a specific patient questionnaire for CI
- In this cohort over 80% of patients who meet the criteria for implantation were not referred. This data suggests :
  - Patients need better counselling
  - Health professional greater education
  - Referral processes should be improuved

FACTORS IMPACTING CI OUTCOMES

- A number of patients do not reach optimal performance according to their own prognosis factors,
- What can be done in front of a poorer performer ?