



Challenges and results in pediatric CI therapy - experiences from only 30 years -

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Medical University of Hannover
(Chair: Thomas Lenarz PhD, M.D.)



Clinic of Otorhinolaryngology & Hearing Center / MHH

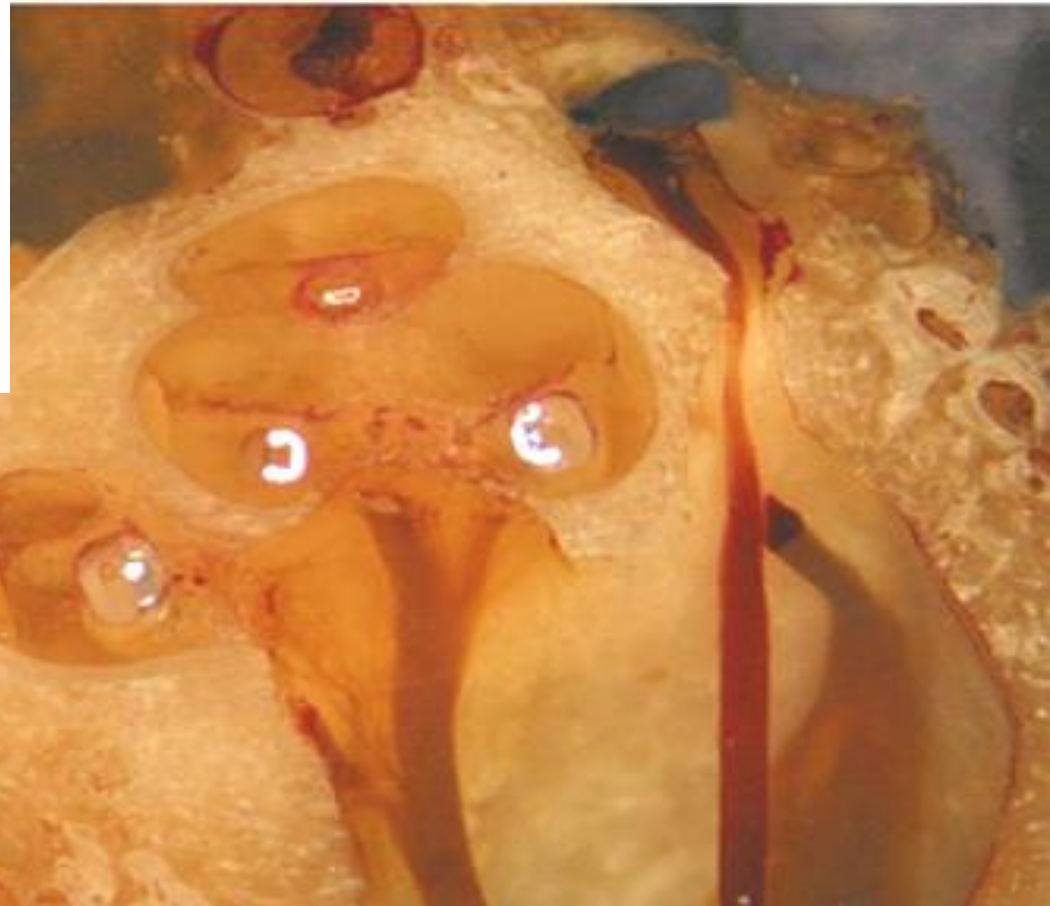
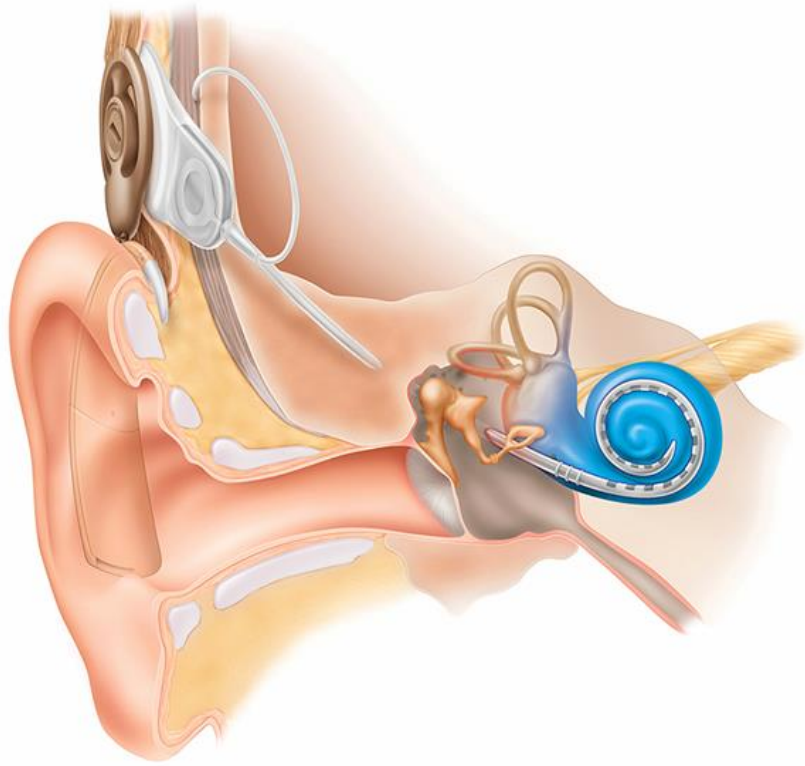


Deutsches Hörzentrum



NIFE

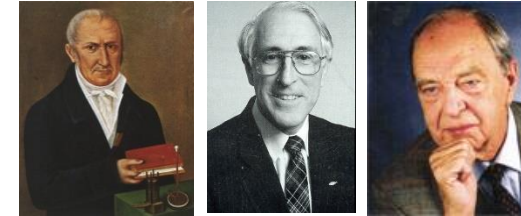
Principles are unchanged



Cochlear Implant:

The “success story” of neuroprosthetic devices

History of Implant



Contact
with the
world of
sound

Speech
discrimination
in a few

Speech
discrimination
in a majority

Speech
discrimination
in all

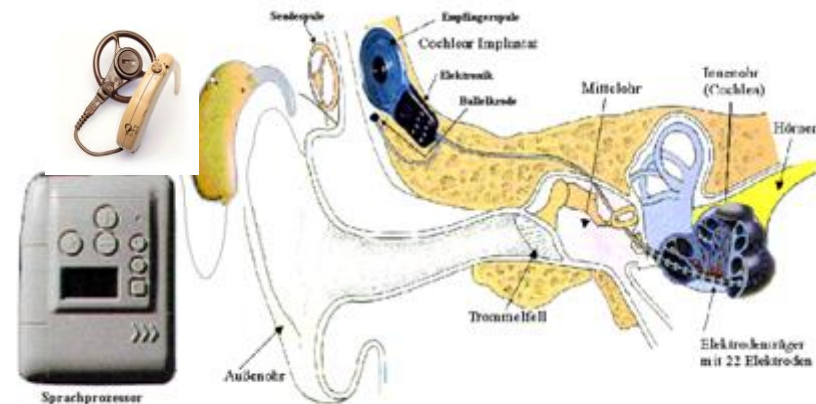


First

Then

Now

Future



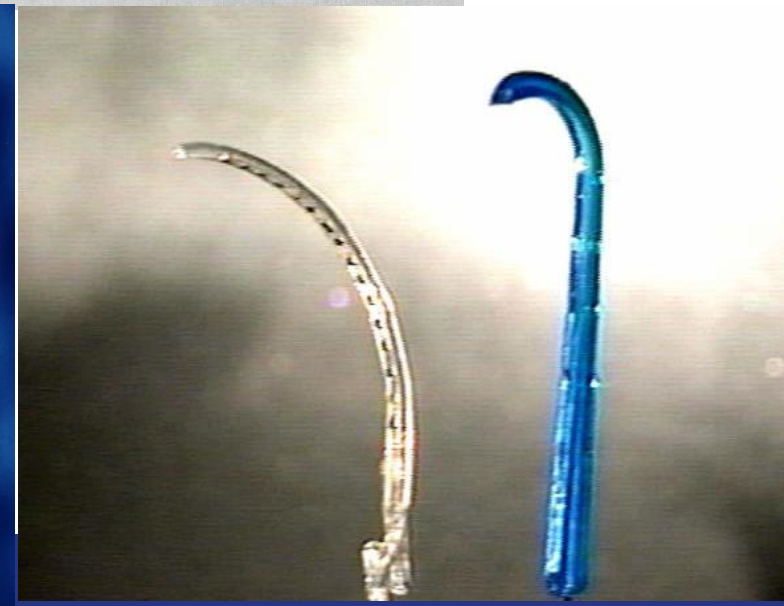
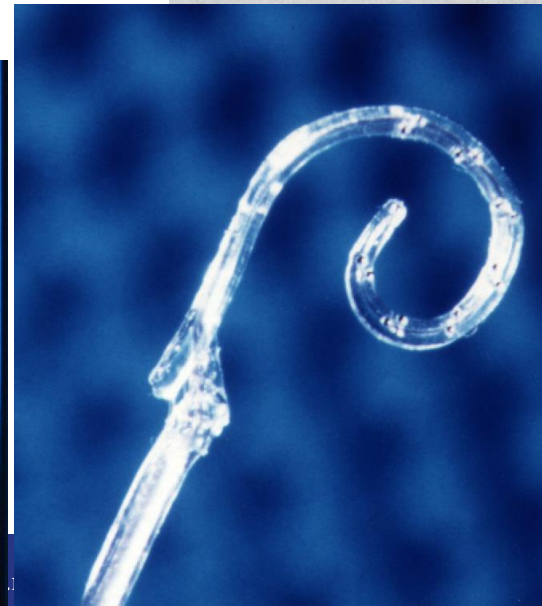
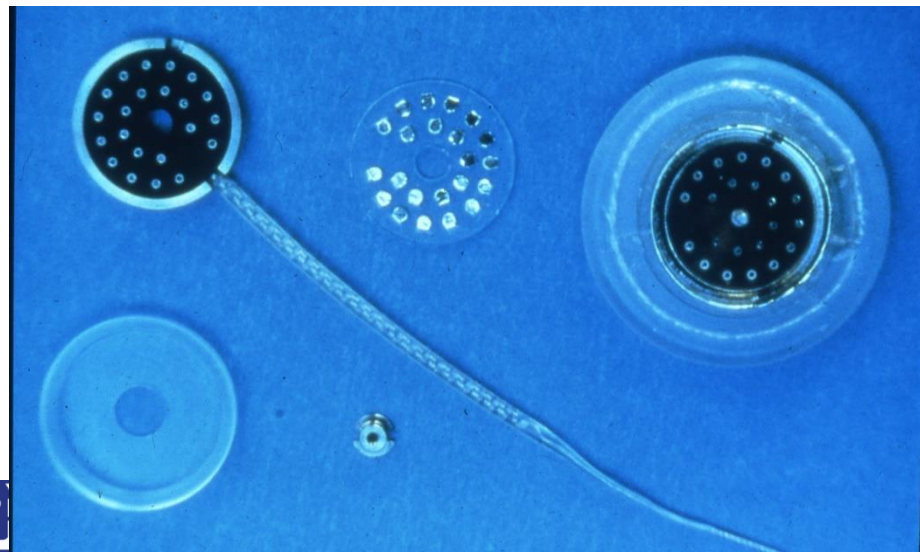
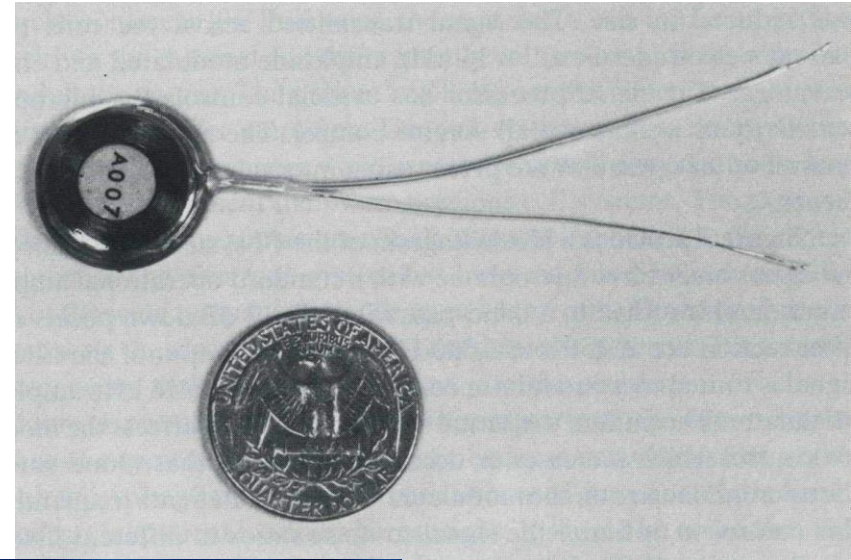
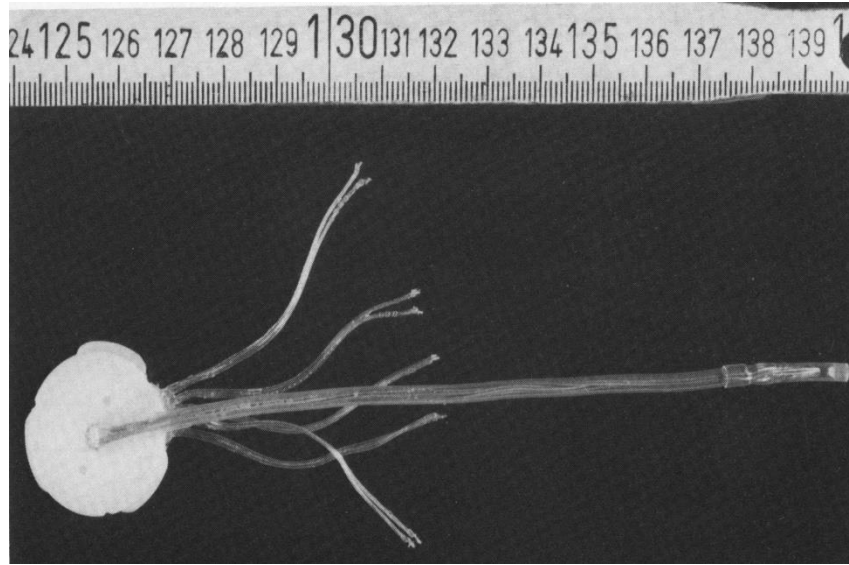
From cable to CI



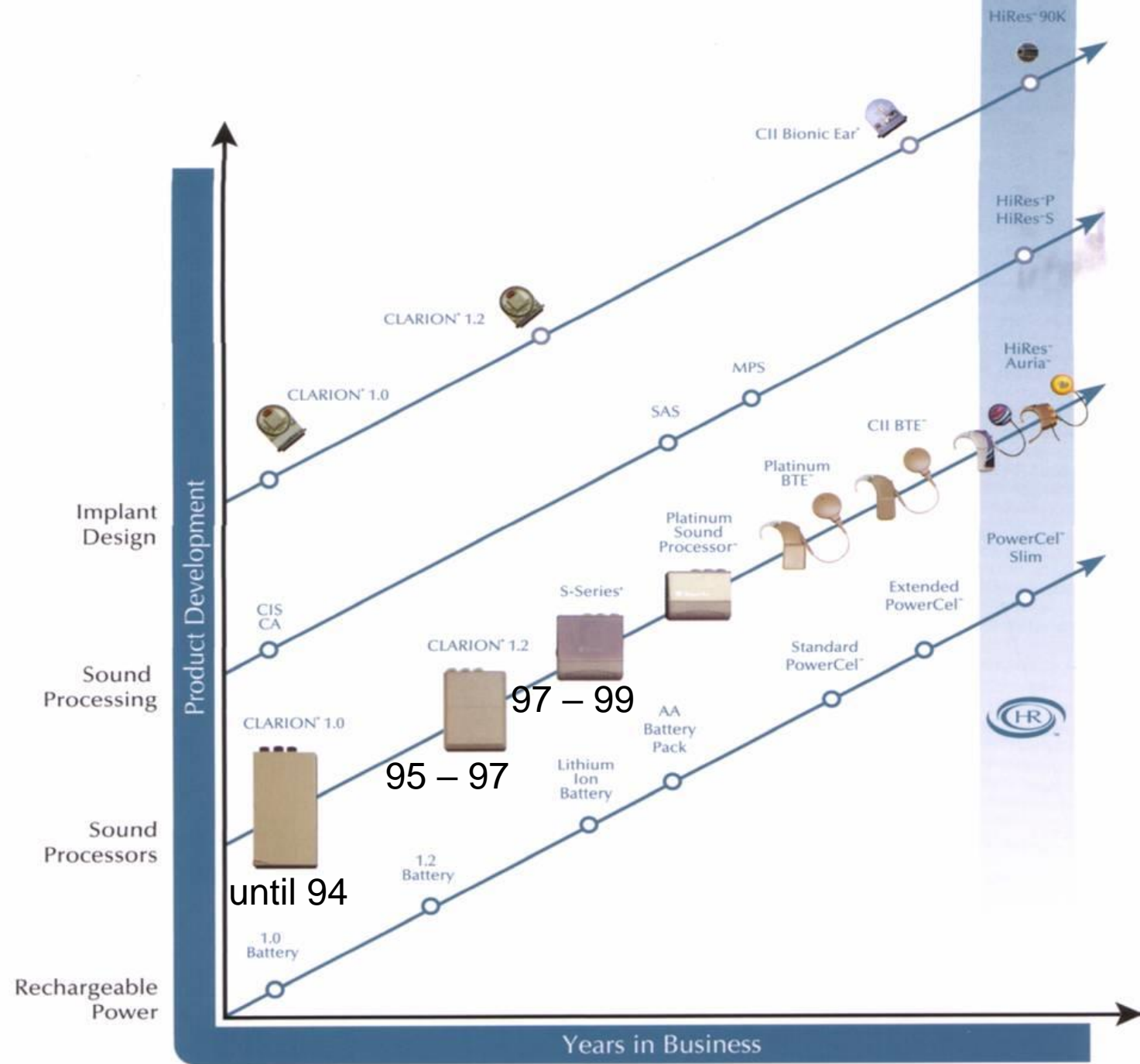
1790 A. Volta → 1950 A. Djourno & C. Eyries
→ 1961 W House & J Doyle → 1977 K Burian
→ 1984 Graeme Clark (FDA approved)
& E. Lehnhardt 1. CI Hannover

Cochlear Implant Design

Design 1984 -2010



Speech processor development



Providing CI in children

NHS

Tracking
Init. therapy

Complete
diagnostics

Cochlear Implant
surgical
procedure

Baisc fitting

Life long Care
eHealth

Inclusion

Reimplantation
Congenital CI recipients

Molecular Inner Ear Therapy

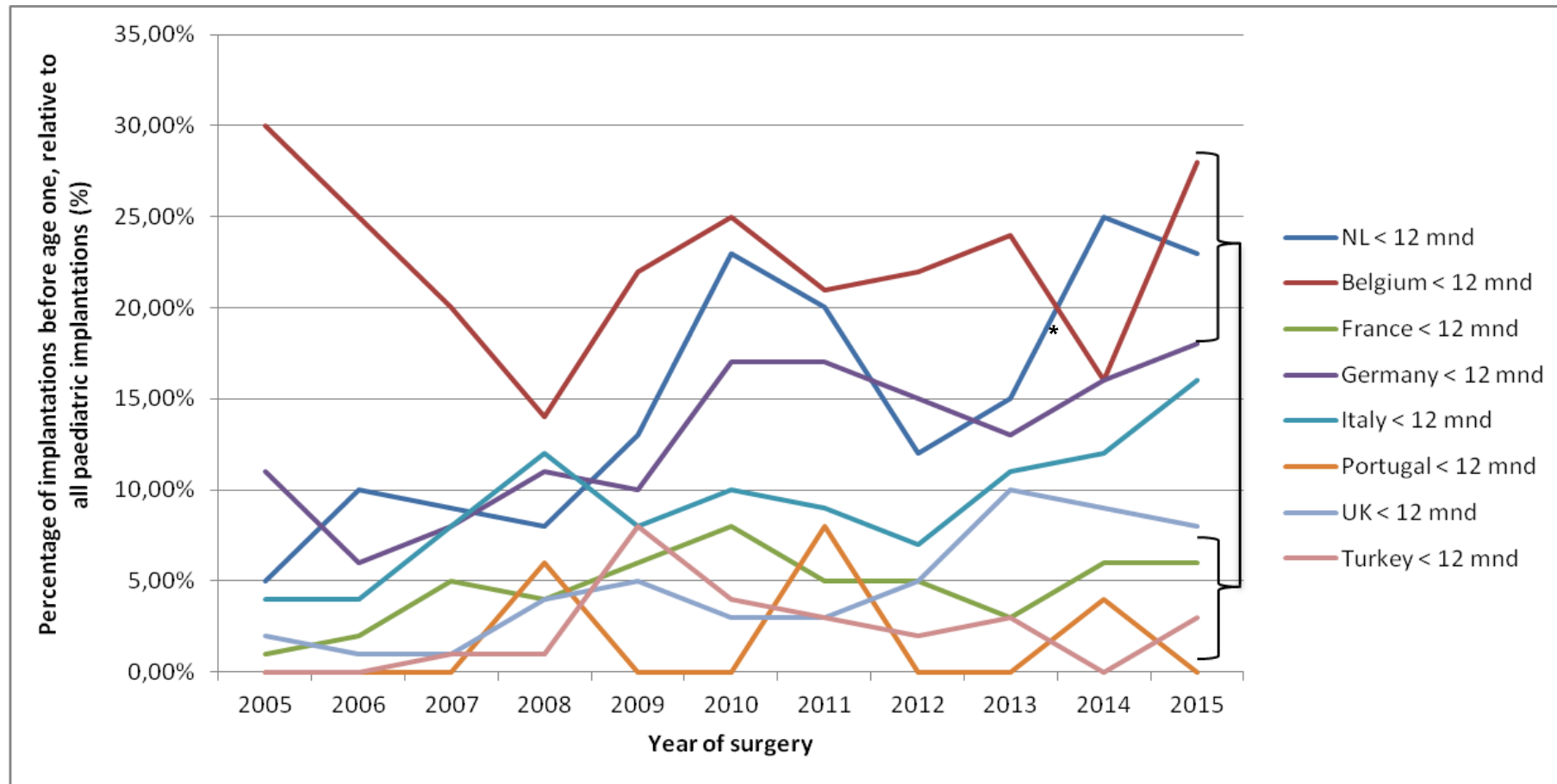
*experience based
constant
development*

eHealth

*future
development*

NHS not forcefull

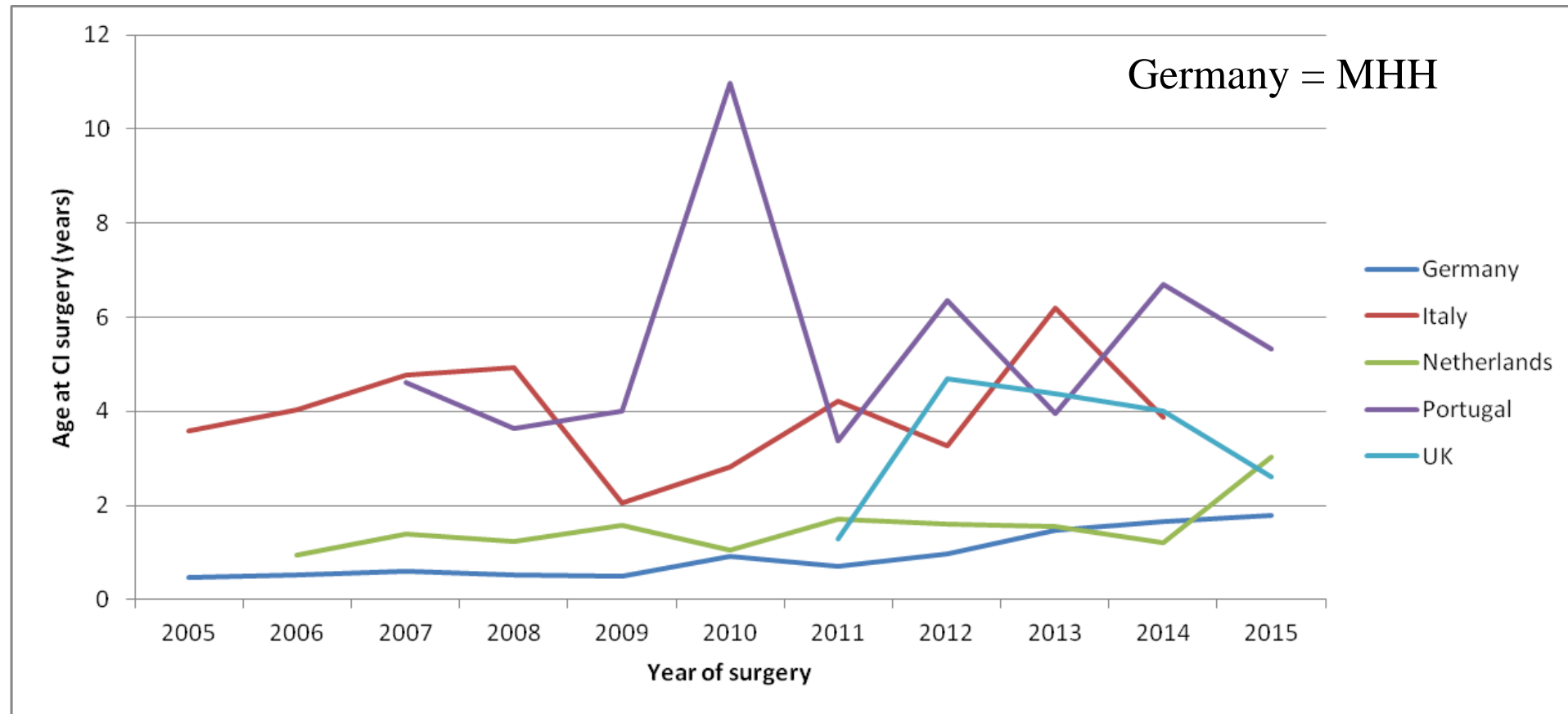
Percentage of children implanted before the age of 12 months in 8 countries between 2005 and 2015 (Cochlear®)



Cochlear Implants International (2017) 18:6, 287-296

NHS not forcefull

Age-at-implantation assessment of all children implanted at 5 European institutions (n = 490)



Cochlear Implants International (2017) 18:6, 287-296

Early-Management of Hearing Impairment in children

- constant available
- reliable professionals
- building up confidence in therapy (CI cannot be tried out)
- preparing premeditation / reducing fear

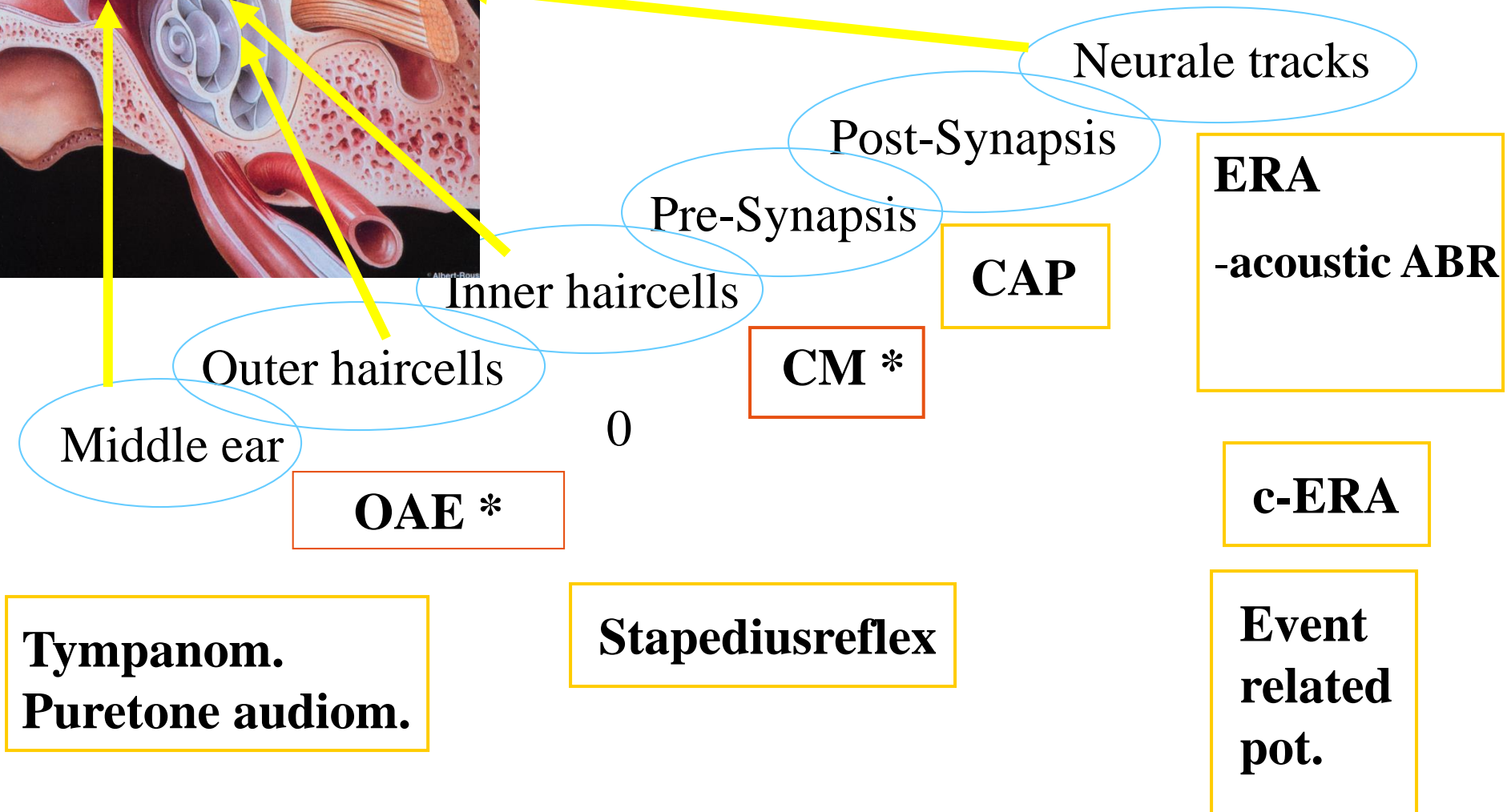
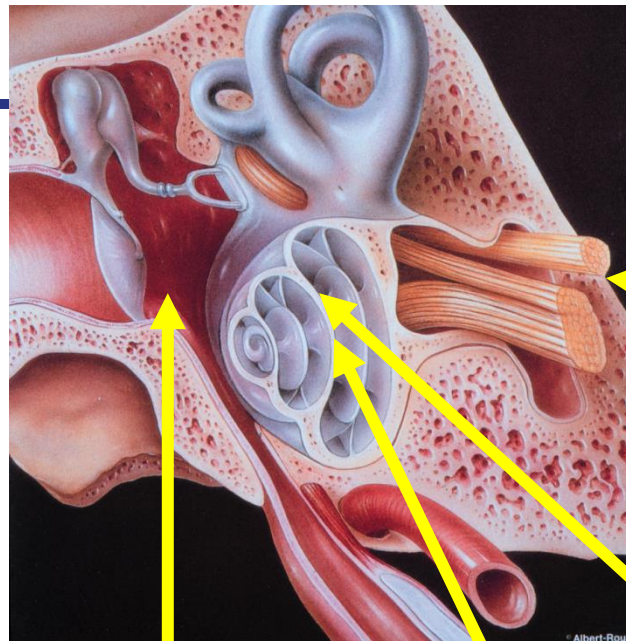
Cave = increasing number in special cases

- children
- seniors

„Complete diagnostics in profound hearing impaired“

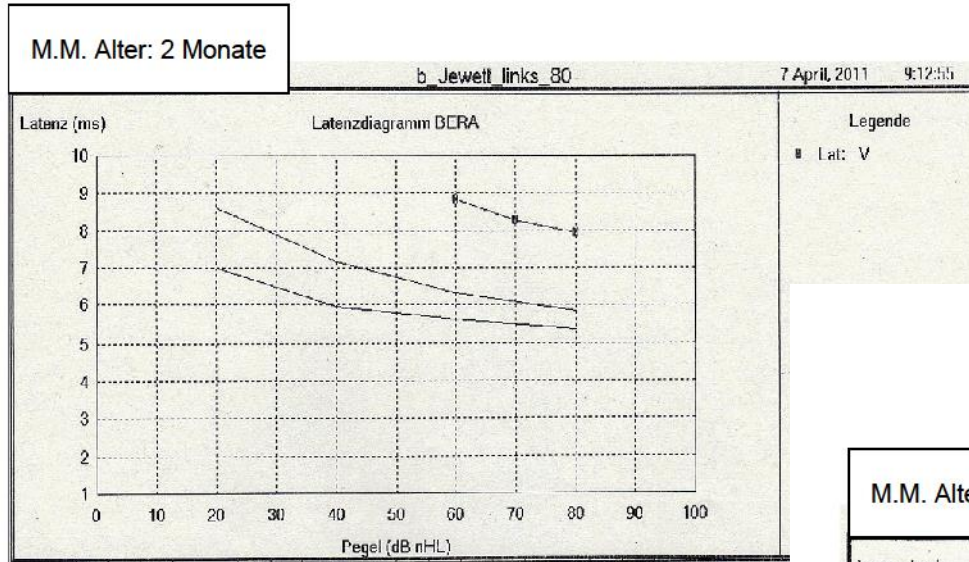
- within 6. / 7. month of life
- middle ear inspection after PC and Adenotomy
- Hearing Aid-audiology and evaluation
- ERA to register threshold
 - ABR, SN10, CAP, ECochG, ASSR
- radiology = CT and MRI
 - ? 3 Tesla , Spektroskopy, ??
- logopedics developmental evaluation
- counseling parents
- additional diagnostics (neuropediatrics, genetics, ...)

Audiological diagnostics

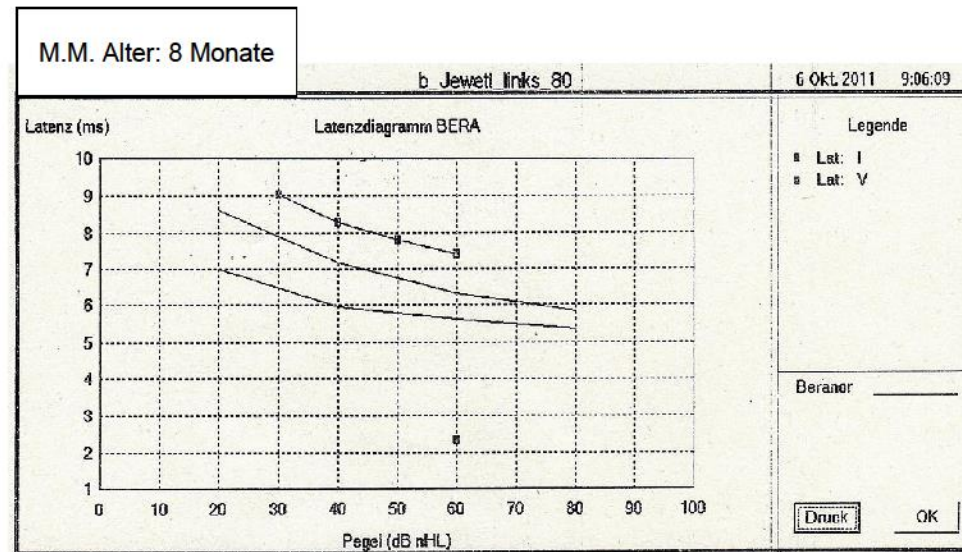


Development of neural plasticity

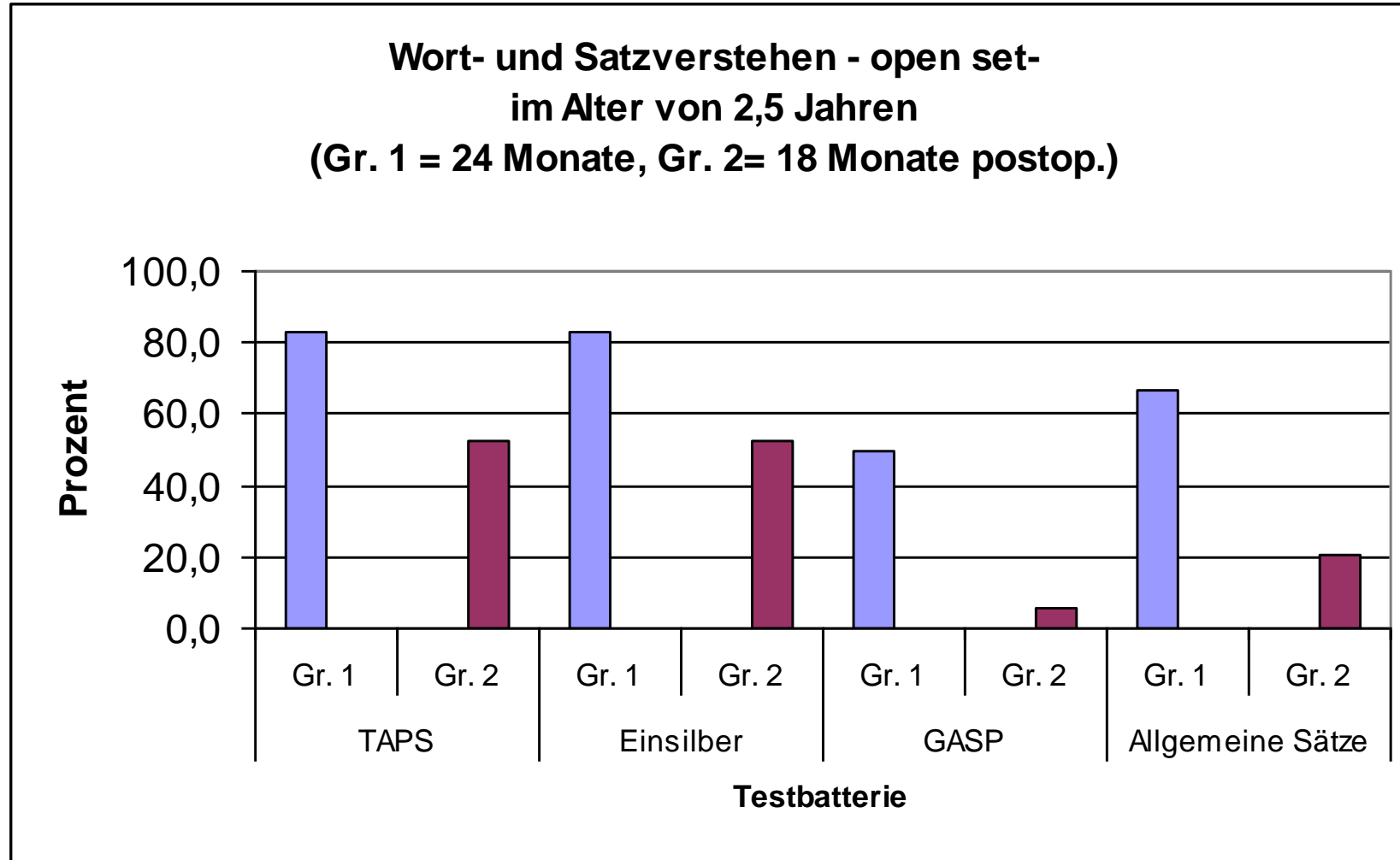
Verzögerung in der Hörbahnreifung
Reizantwort links bis 60 dB



Verzögerung in der Hörbahnreifung
Reizantwort links bis 60 dB

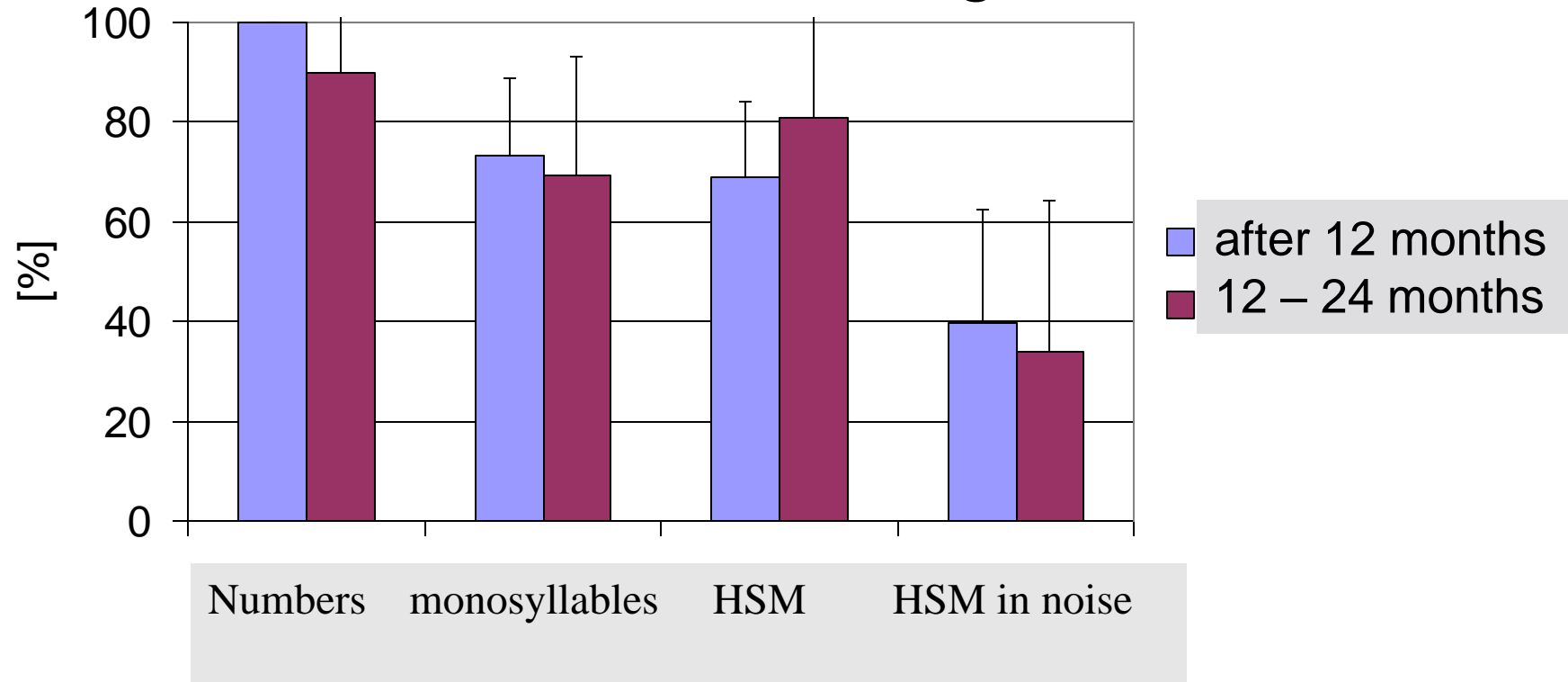


Development of Speech understanding



Results after 9 – 10 years

No signif.diff.



Gr. 1 N= 4

6

4

6

Low numbers

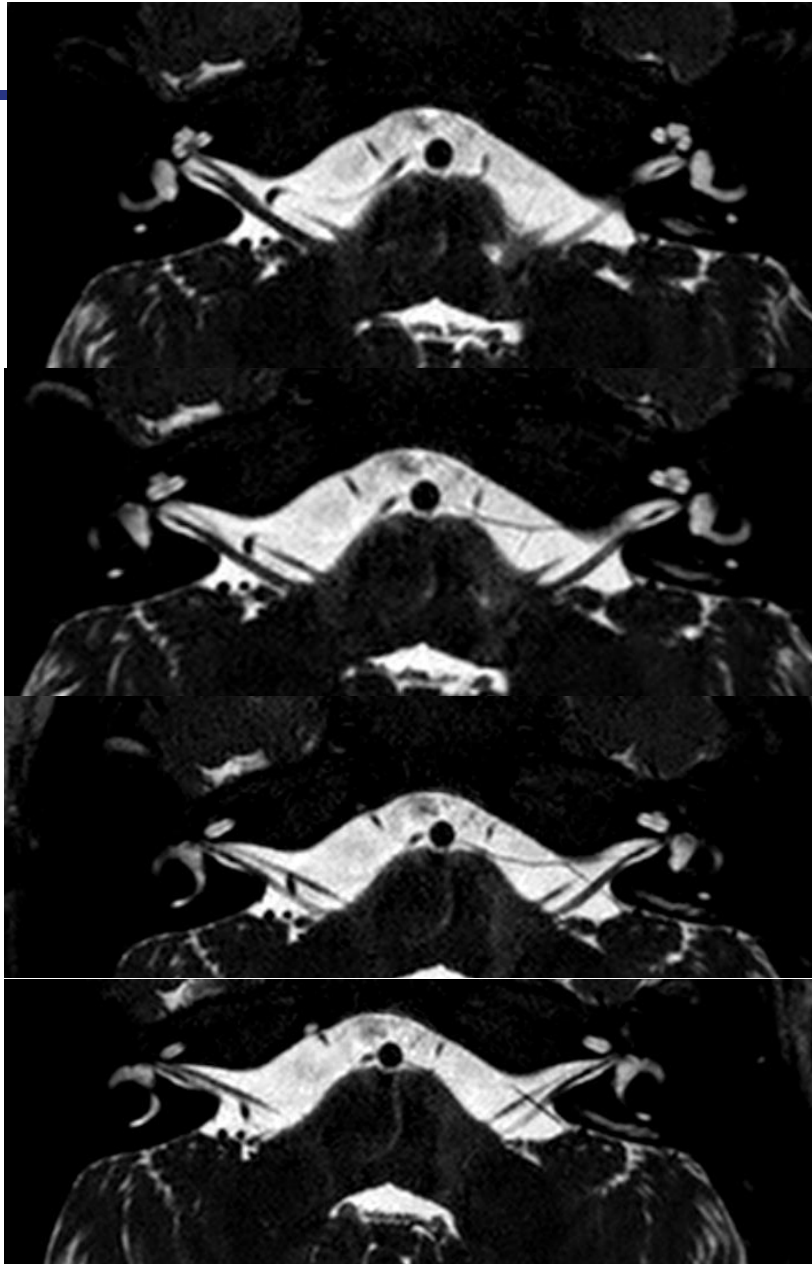
Gr. 2 N= 28

40

36

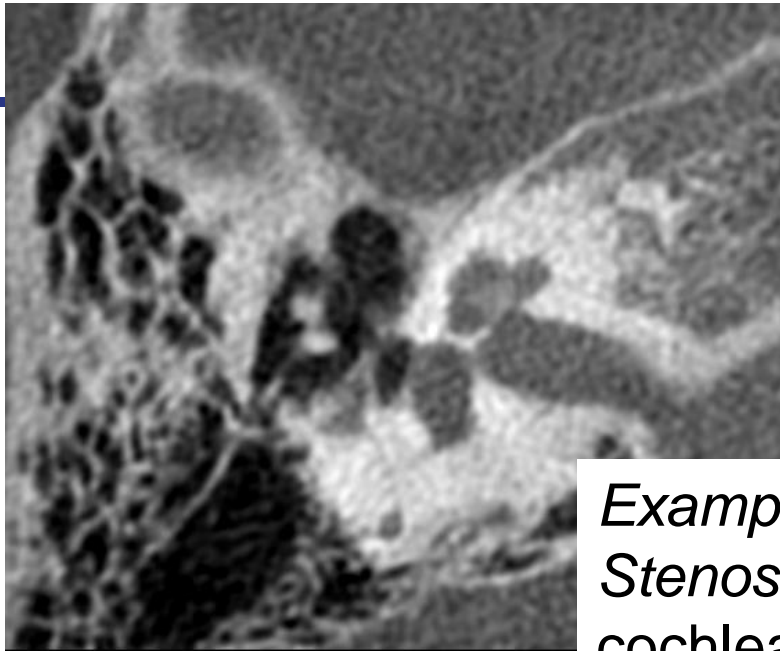
38

Further evaluation

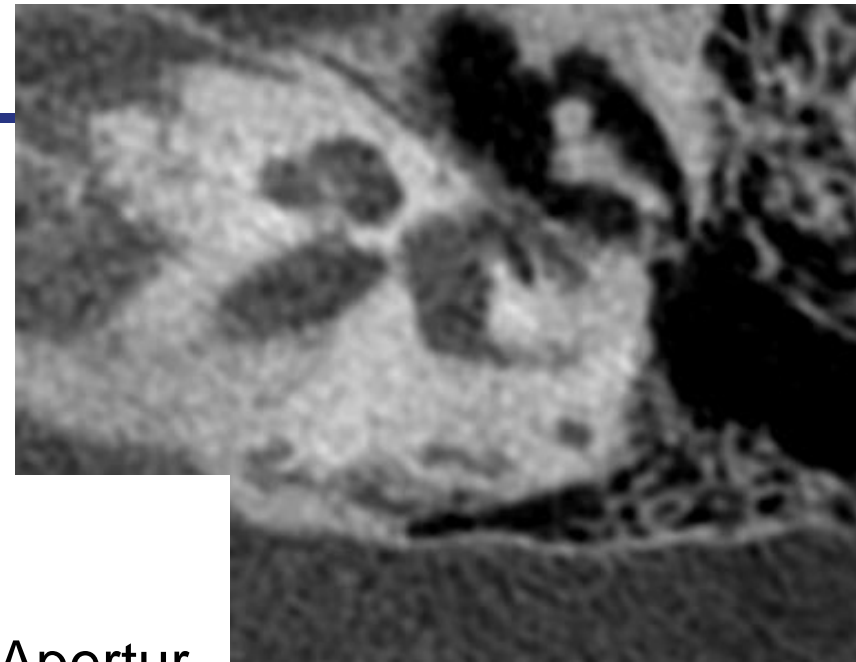


Example:
Stenosis
cochleare Apertur

*28.2.2007 :
Normacusis right
congenital deaf left

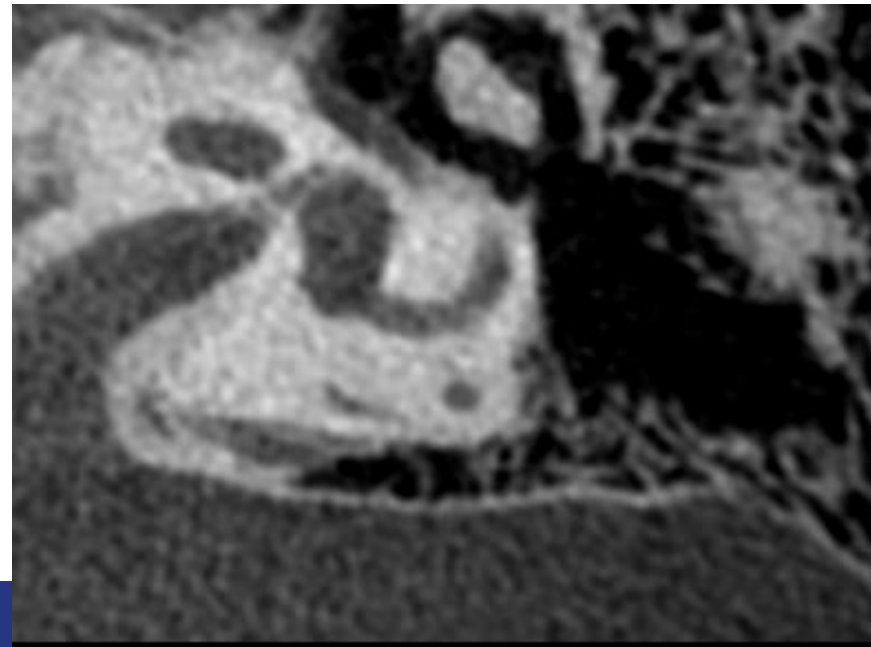
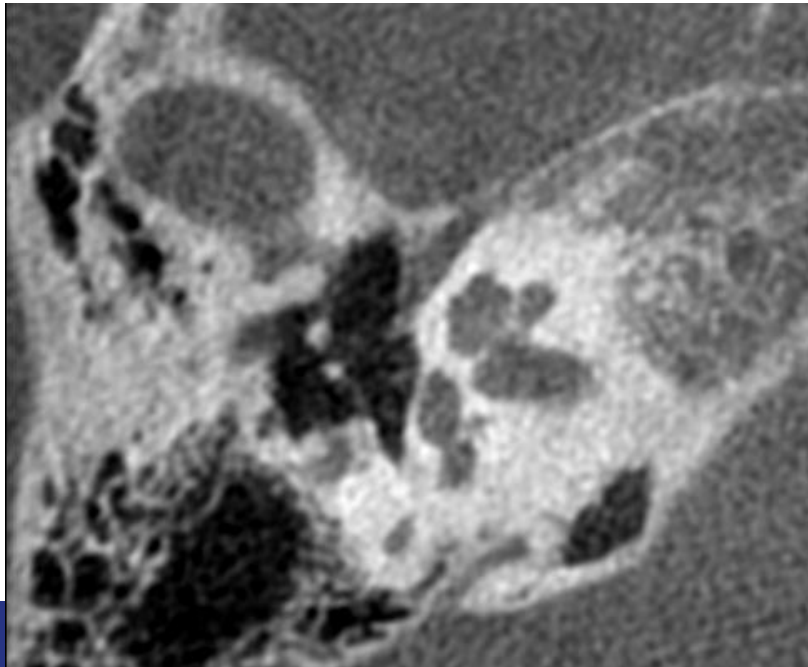


right

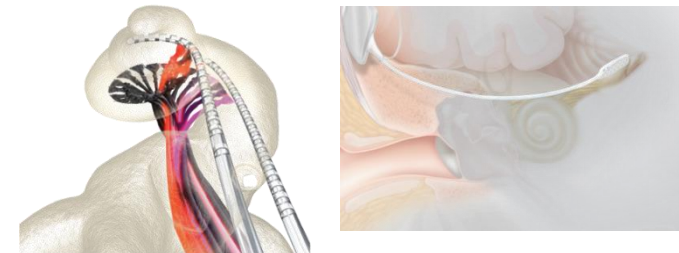
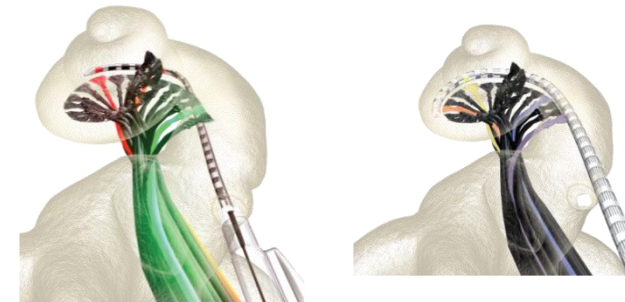
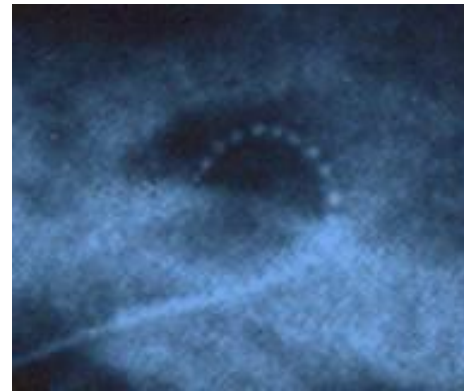
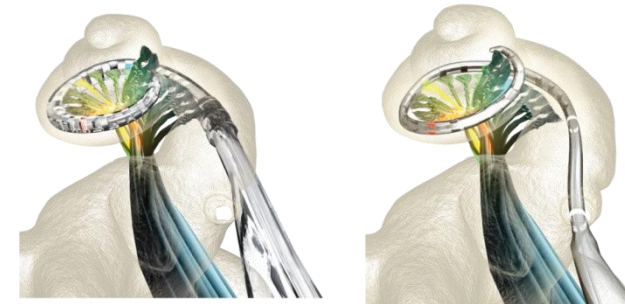
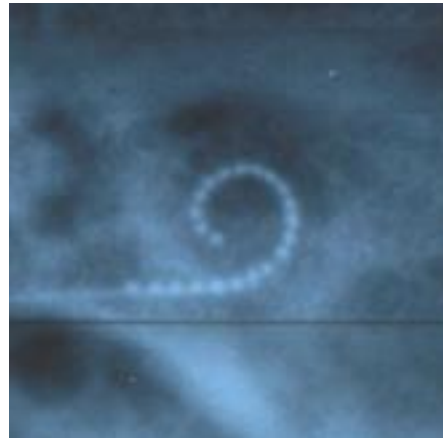
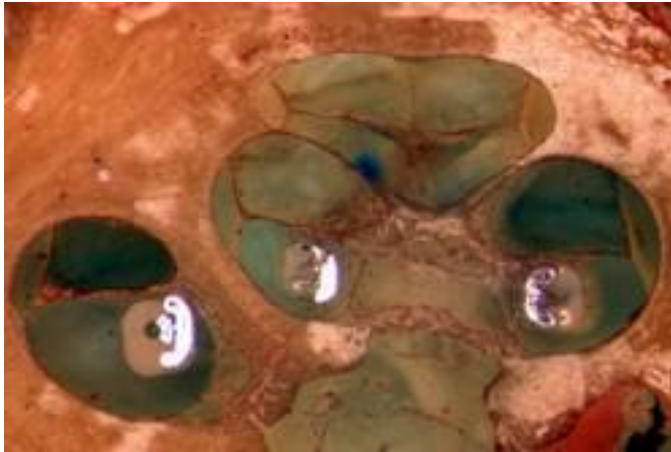


left

Example:
Stenosis
cochleare Apertur

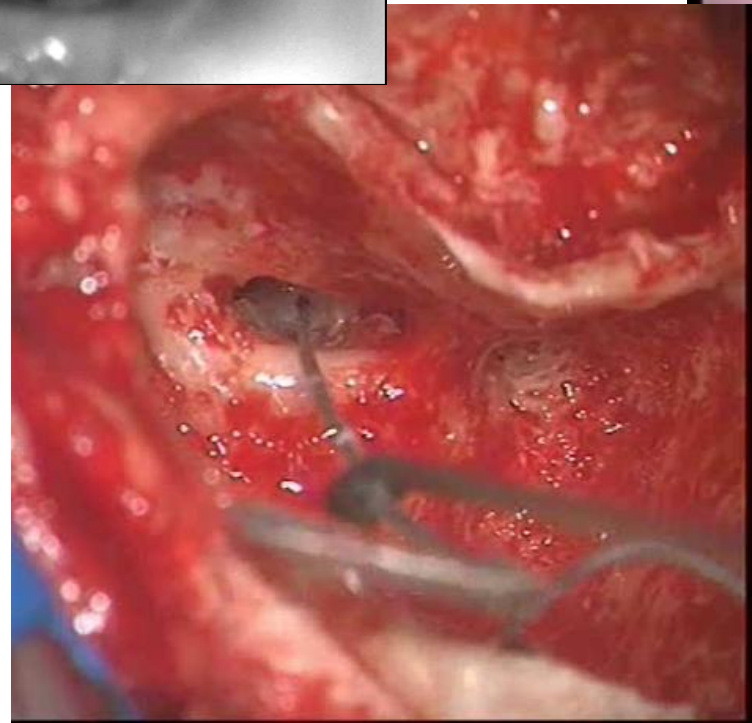
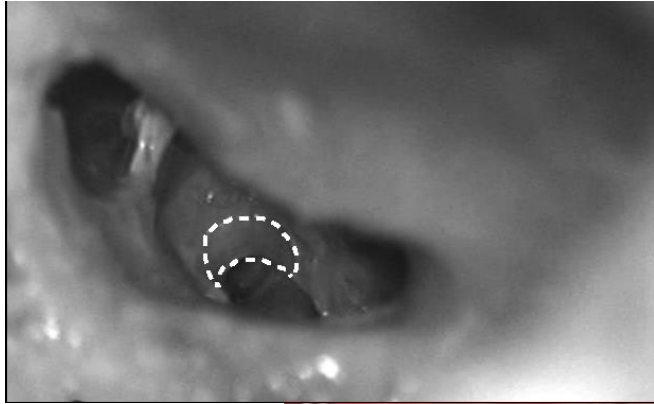


Electrode Design



Insertion PROCEDURE

respecting intracochlear structures

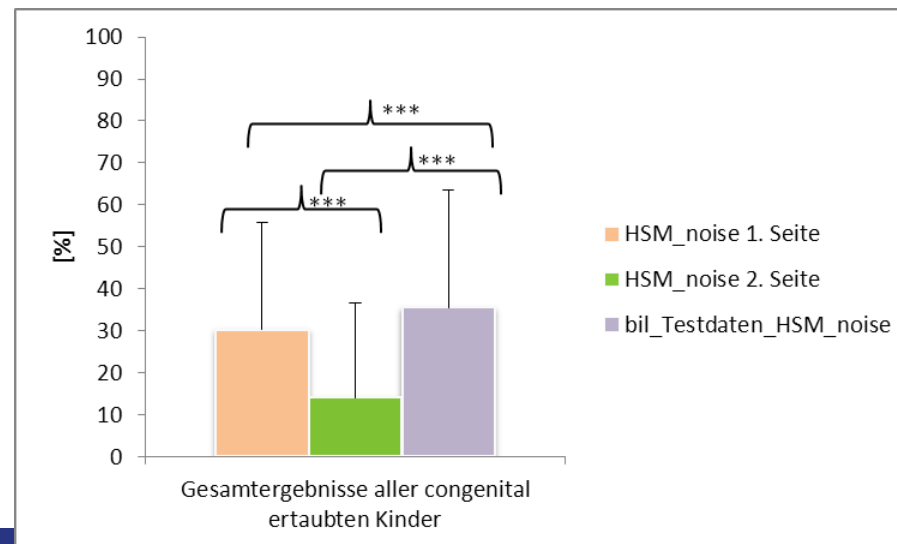
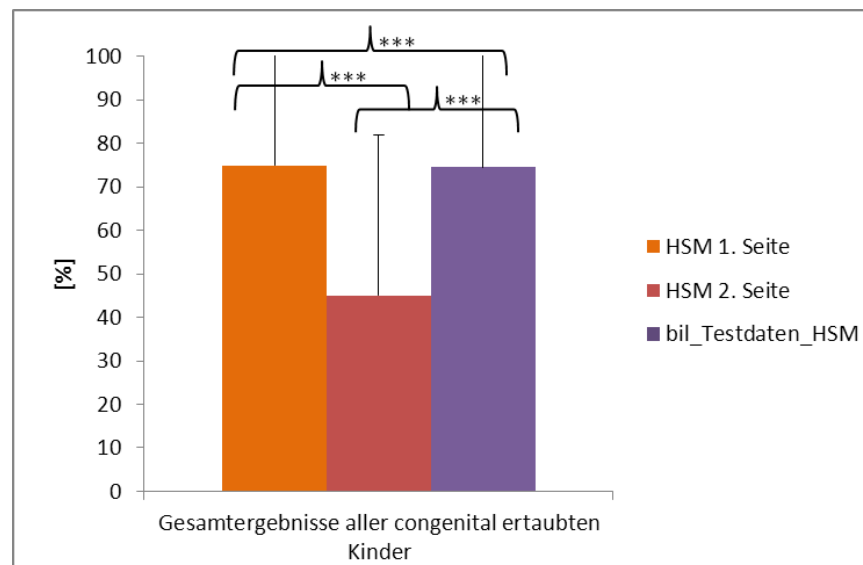
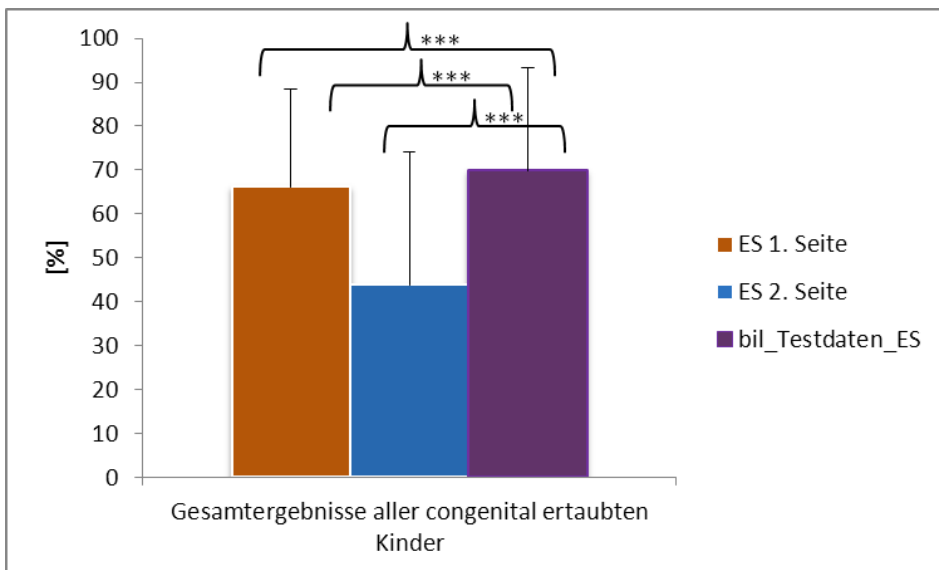


Bilateral CI in Children ? – *sequential* -

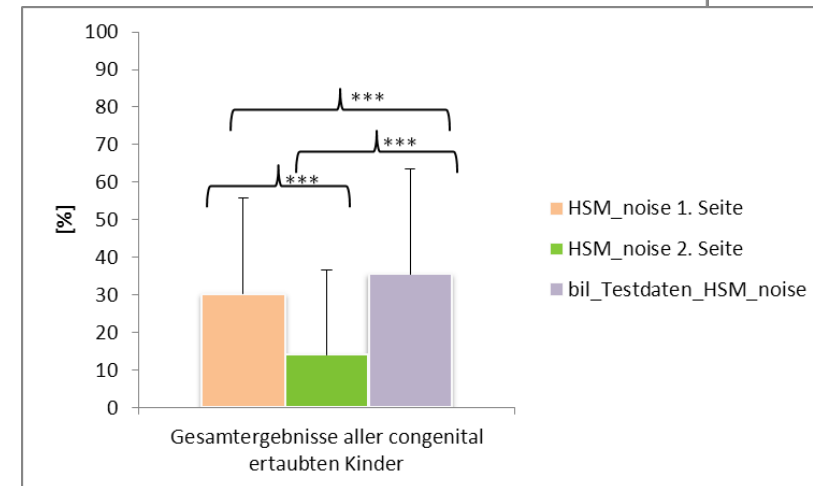
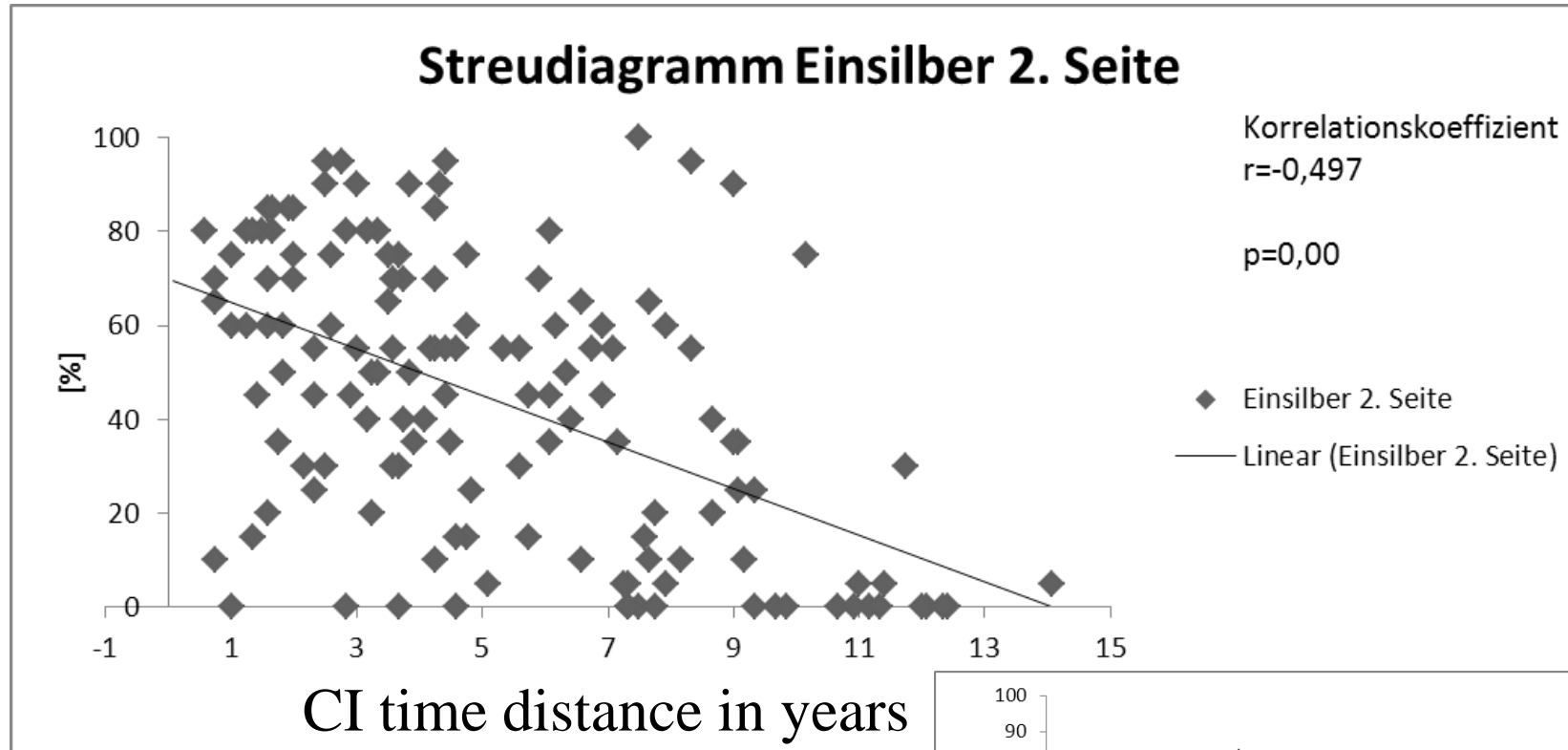
Retrospective Study

- 251 congenital deaf children, age while study 4 - 20 years
- CI-time-period: 2 months up to 14 years
- 2. Side minimum 1 year
- Speech perceptive tests, last test result
- Freiburger Monosyllables, HSM-Sentence test in Silence and noise (10 dB S/N Ratio), Freefield 65 dB
- 110 answers

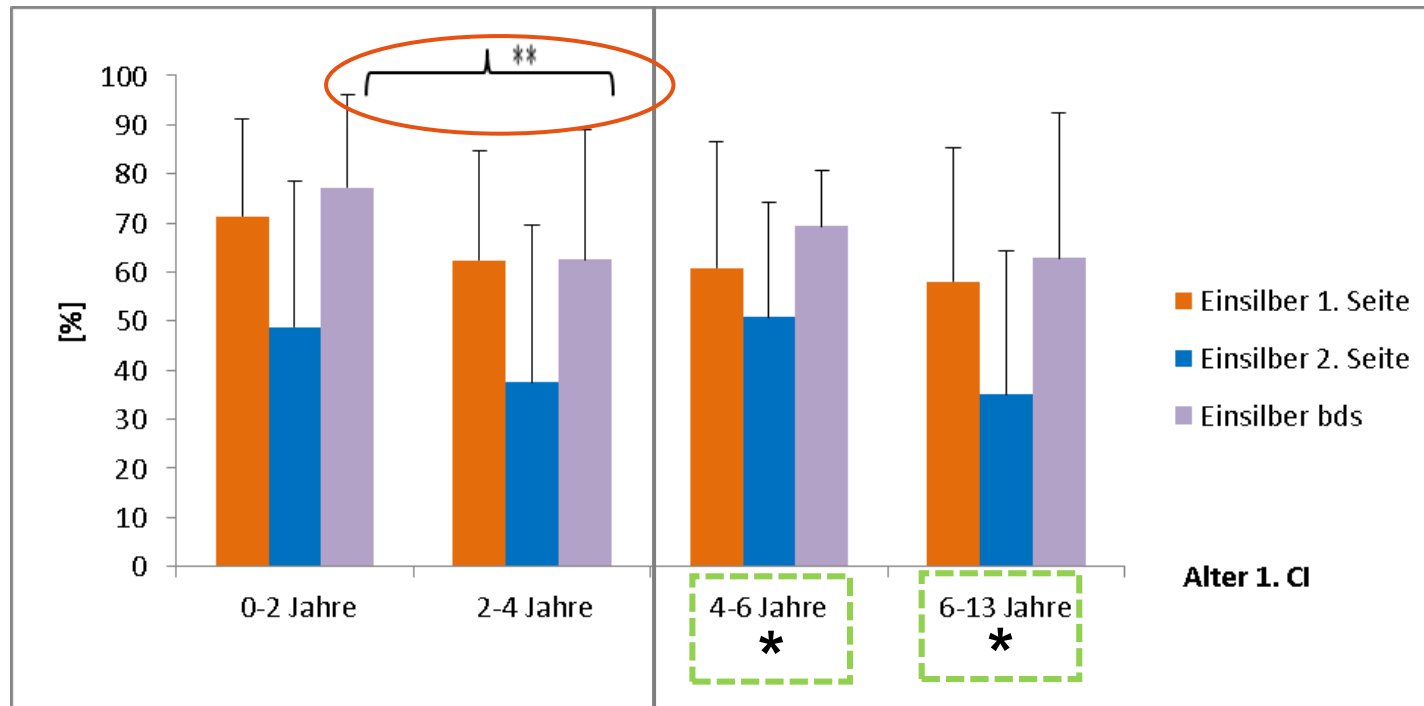
Results all children



Correlation 2. side ~ CI time period



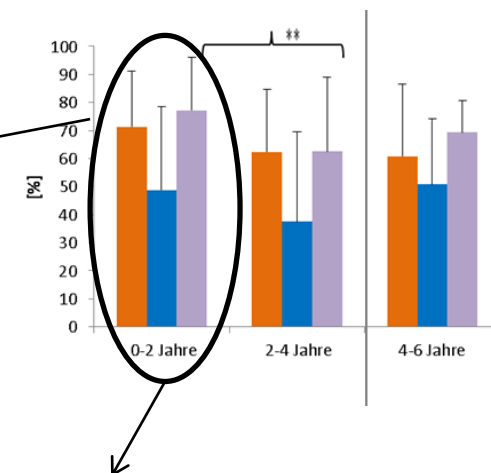
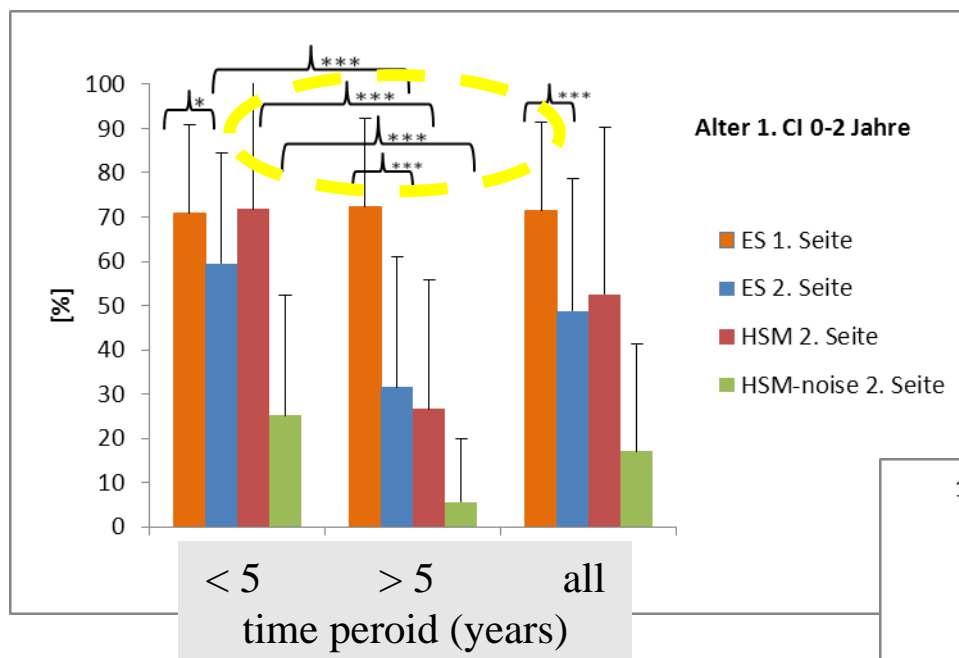
Monosyllables ~ Age (1. CI)



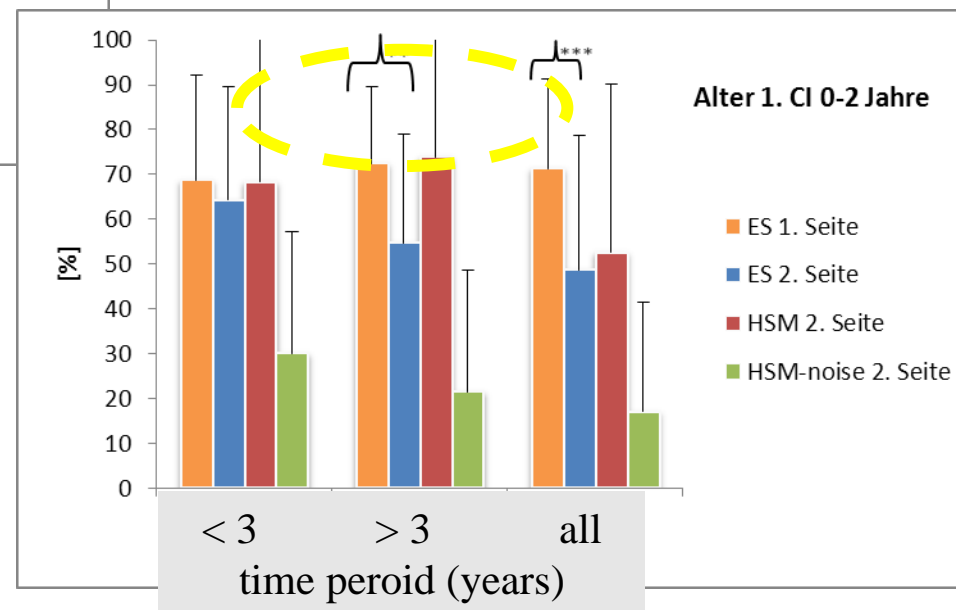
N	0-2 Jahre	2-4 Jahre	4-6 Jahre	6-13 Jahre
ES 1.	66	58	12	8
ES 2.	65	54	12	8
Es bds	77	66	15	9

* nearly all children with residual hearing (125-500 Hz with 60-100 dB)

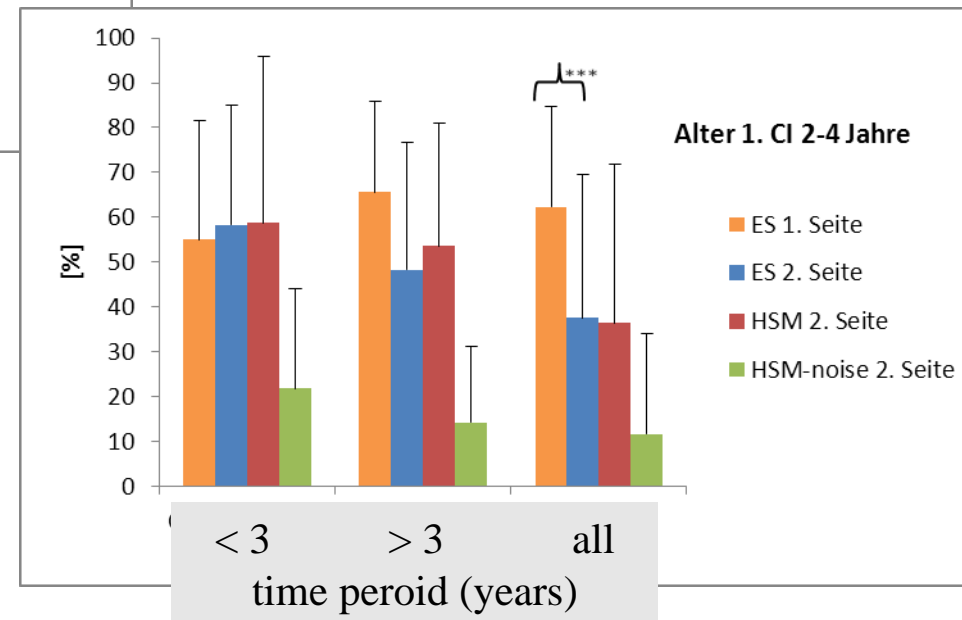
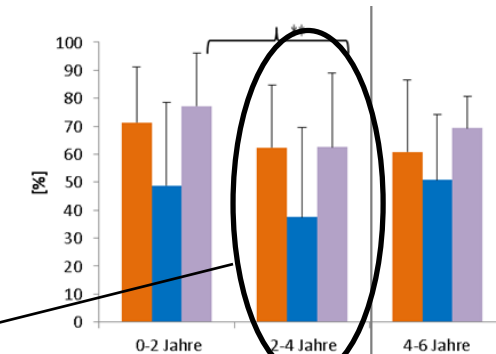
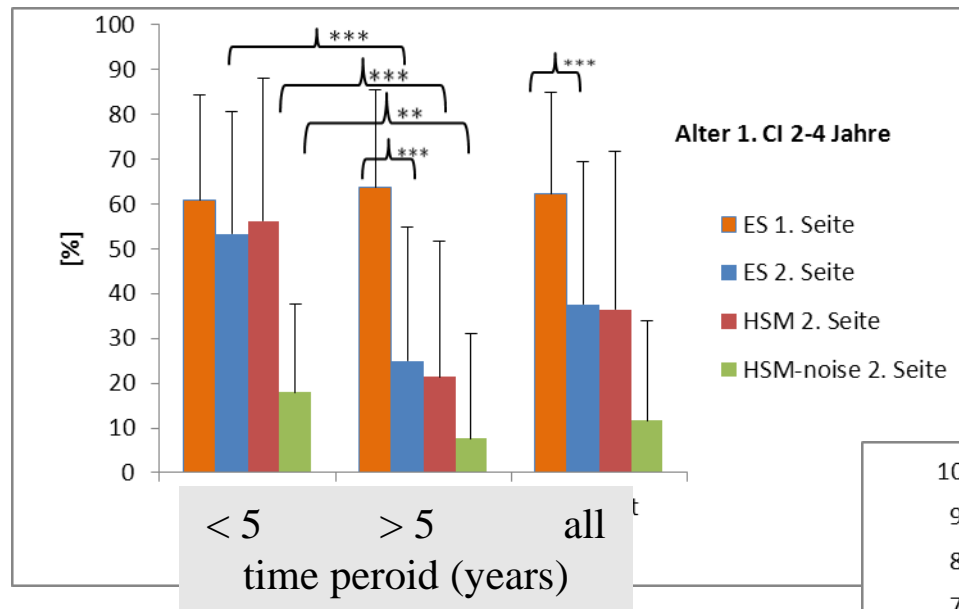
Correlation Age (1. CI) ~ CI Time period



consequences

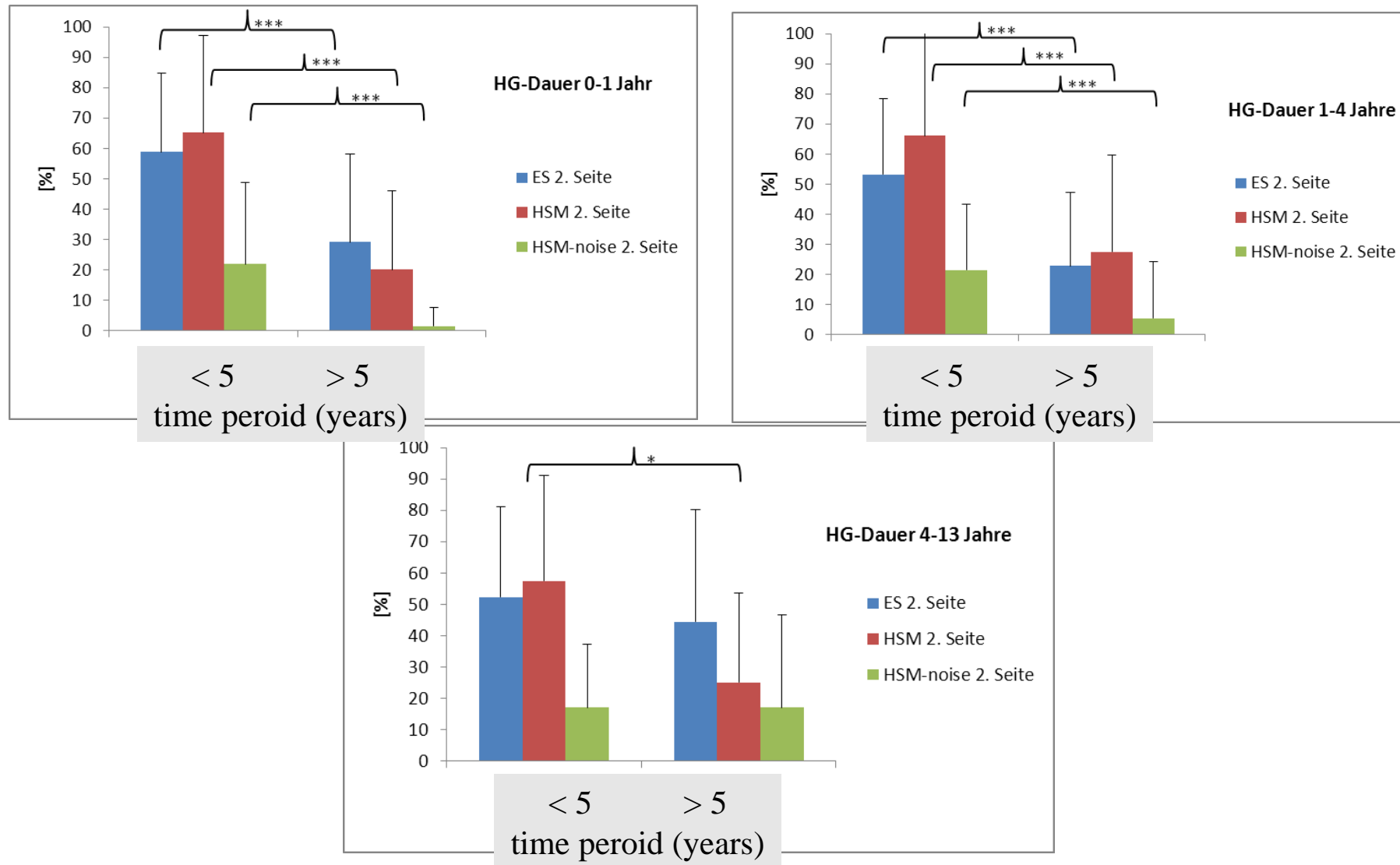


Correlation Age (1. CI) ~ CI Time period



consequences

Correlation 2.CI and HA and CI time period



SSD in children

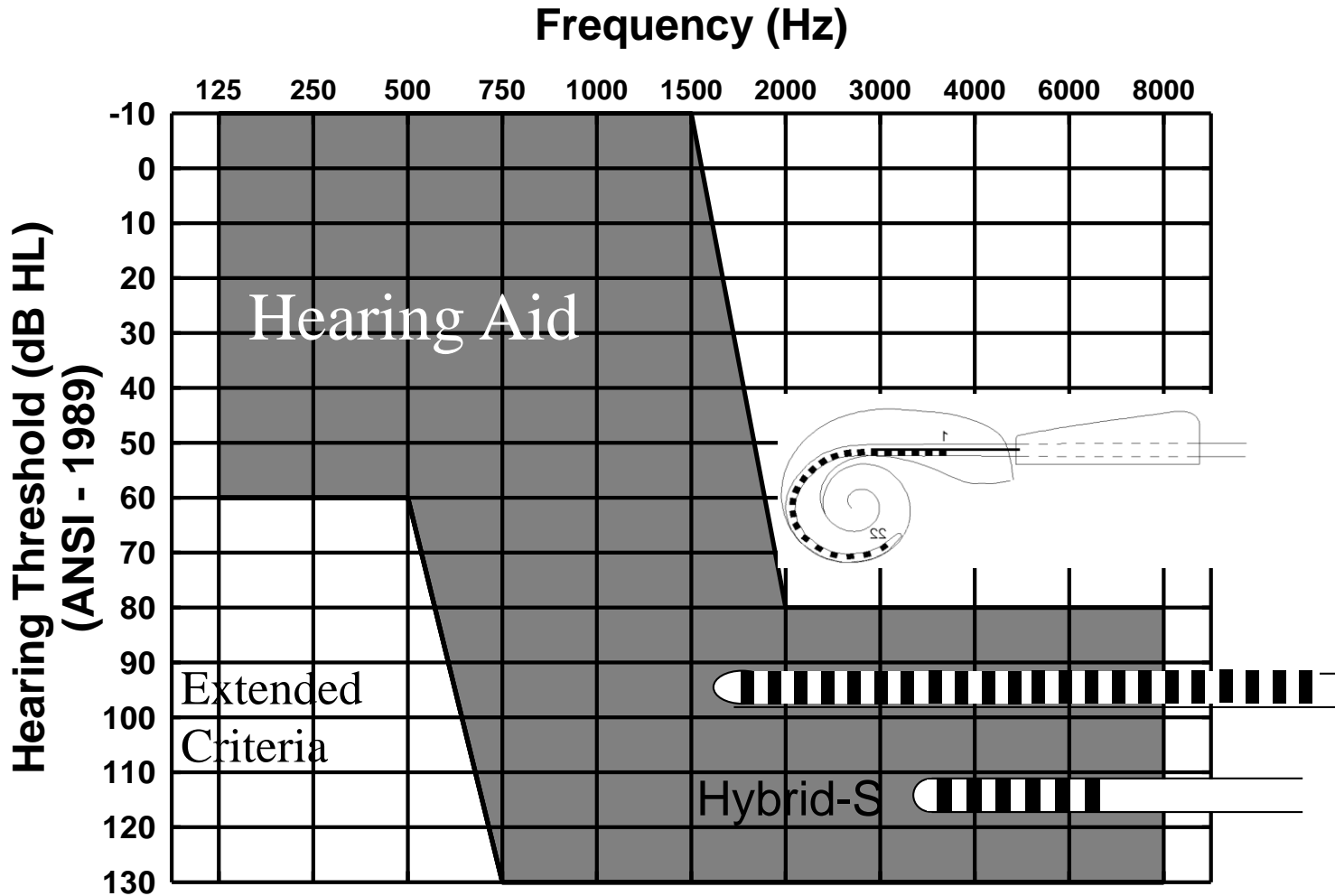
Learning from **MHH-data** & **6th Europ Pediatric Conf.**

1. Diagnostics 6th months = MRI 3 Tesla loop & ECochG
2. Experienced based counseling with parents networking
3. Options
 1. Immediately CI (direct coupling exercising!)

Cautious parents

1. CROS at age ability & interest in localisation
2. CI latest 3 years of age

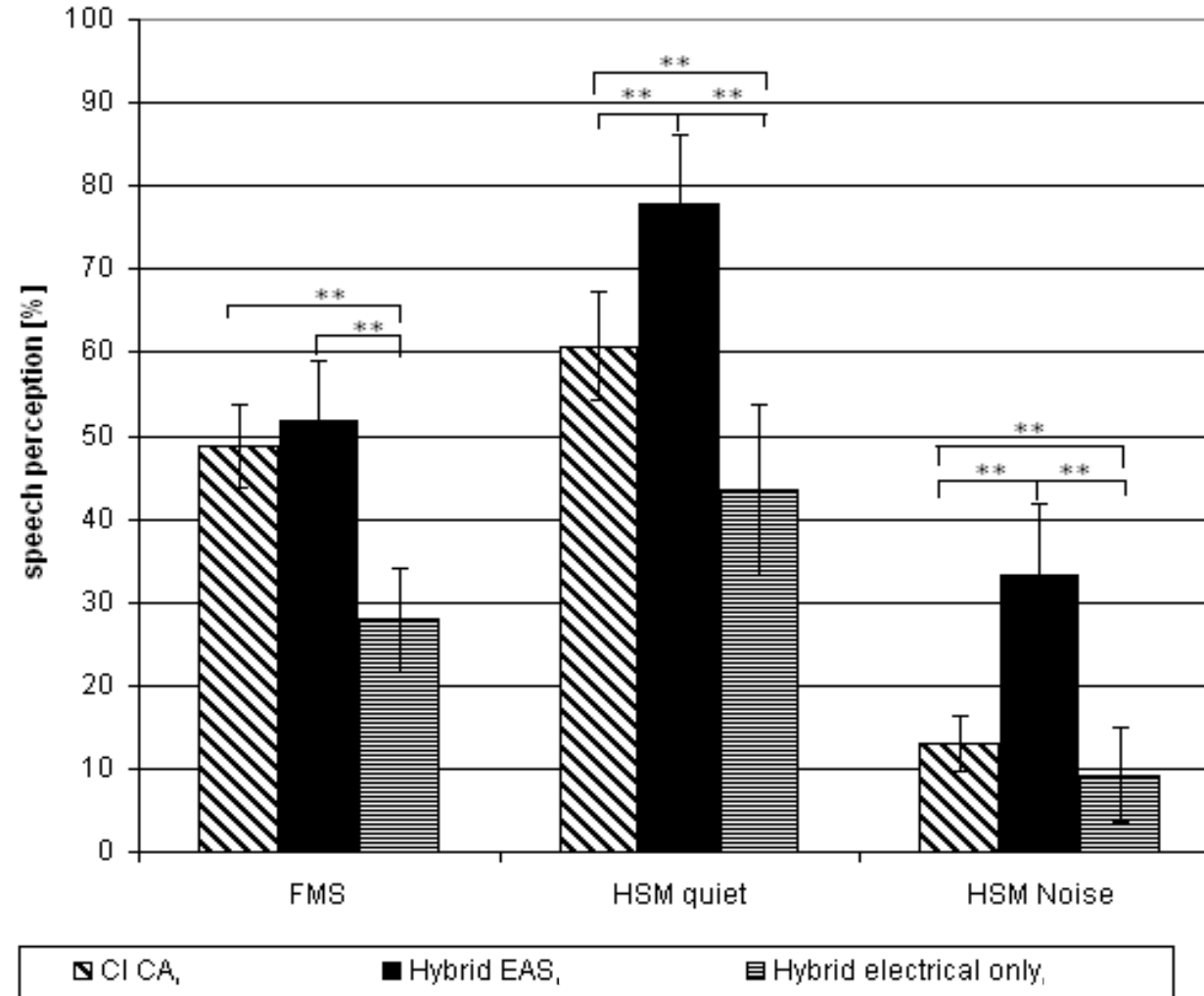
Highfrequency deafness



Speech understanding after 6 months

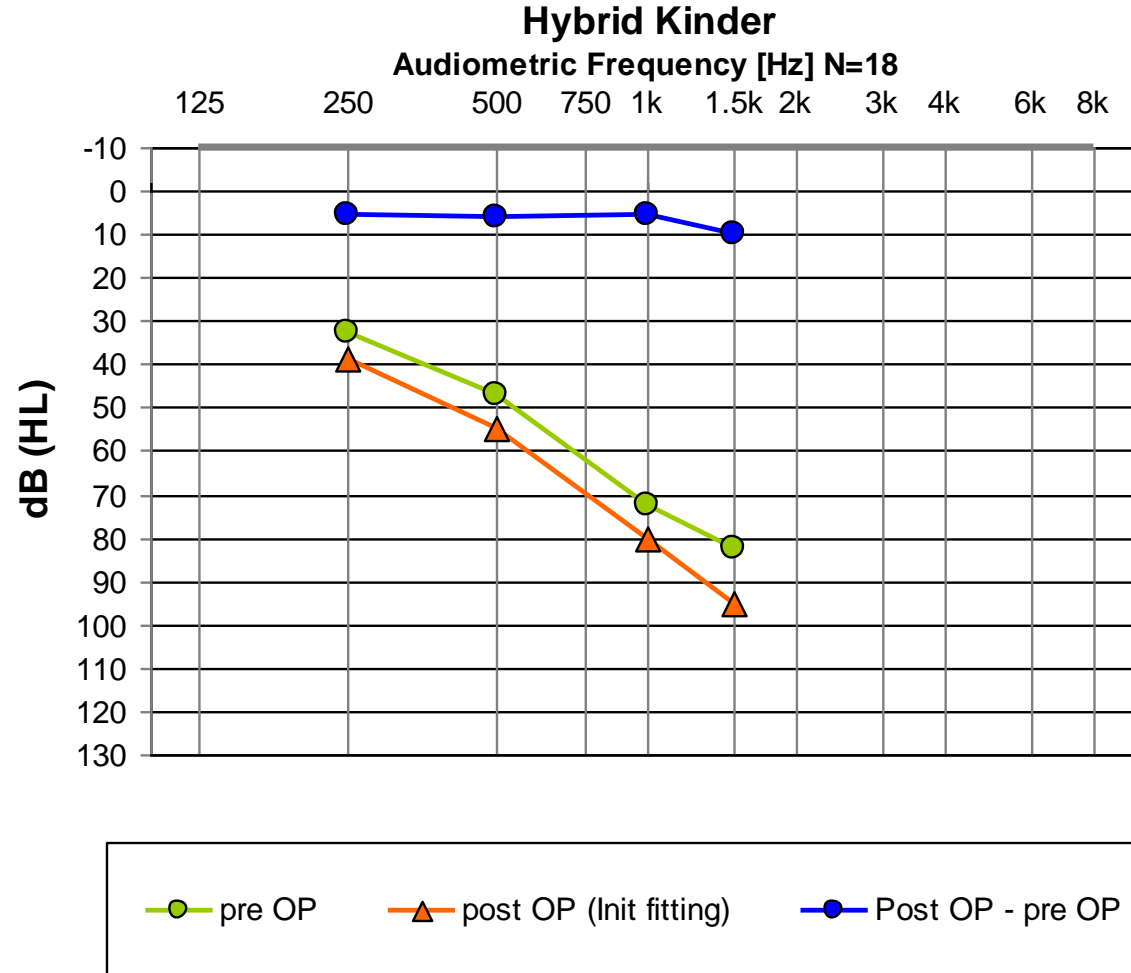
Hybrid-L (n=80), Reference (n=165)

AVG speech data at 6 month visit

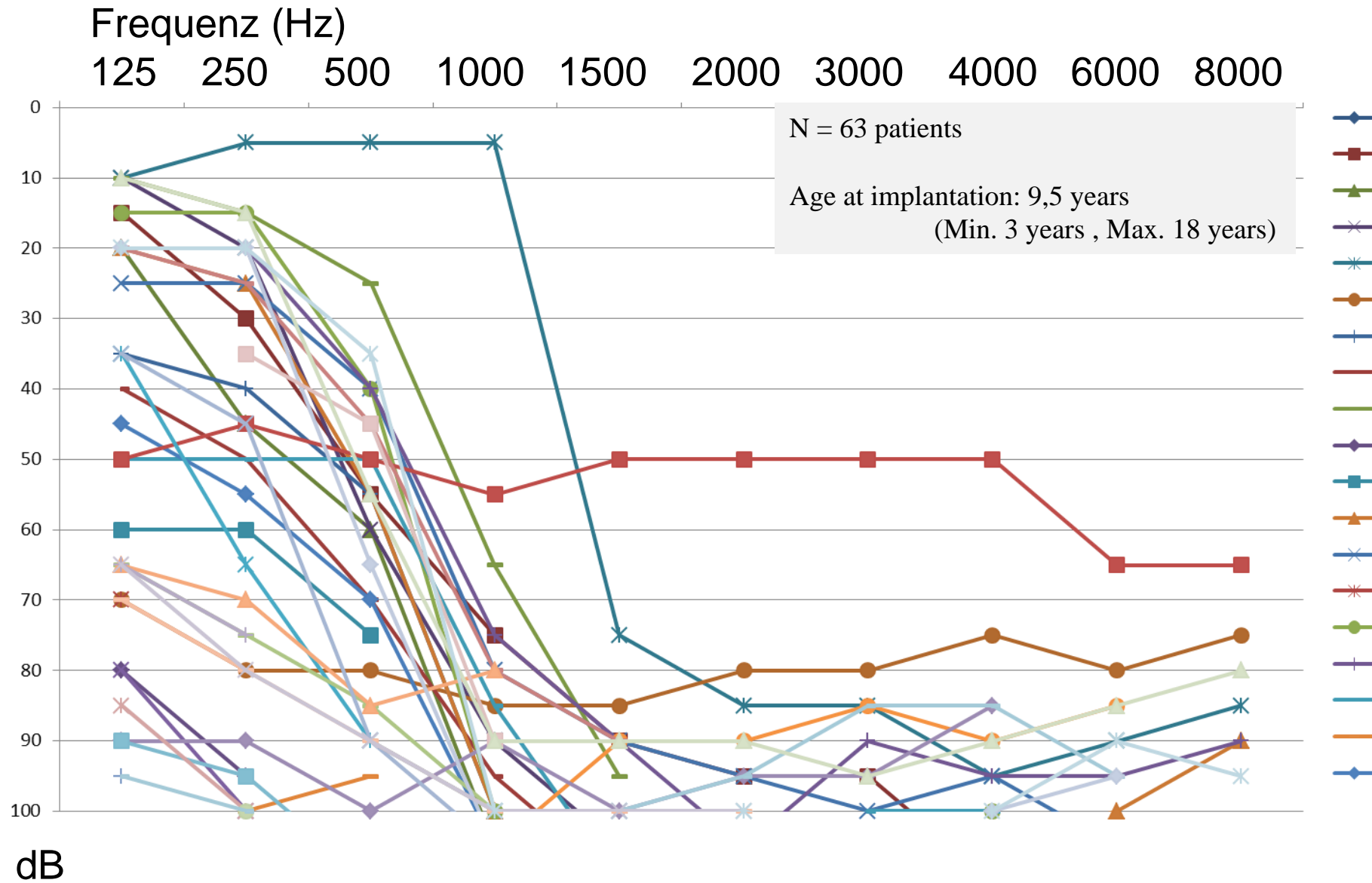


Higfrequency deafness in children

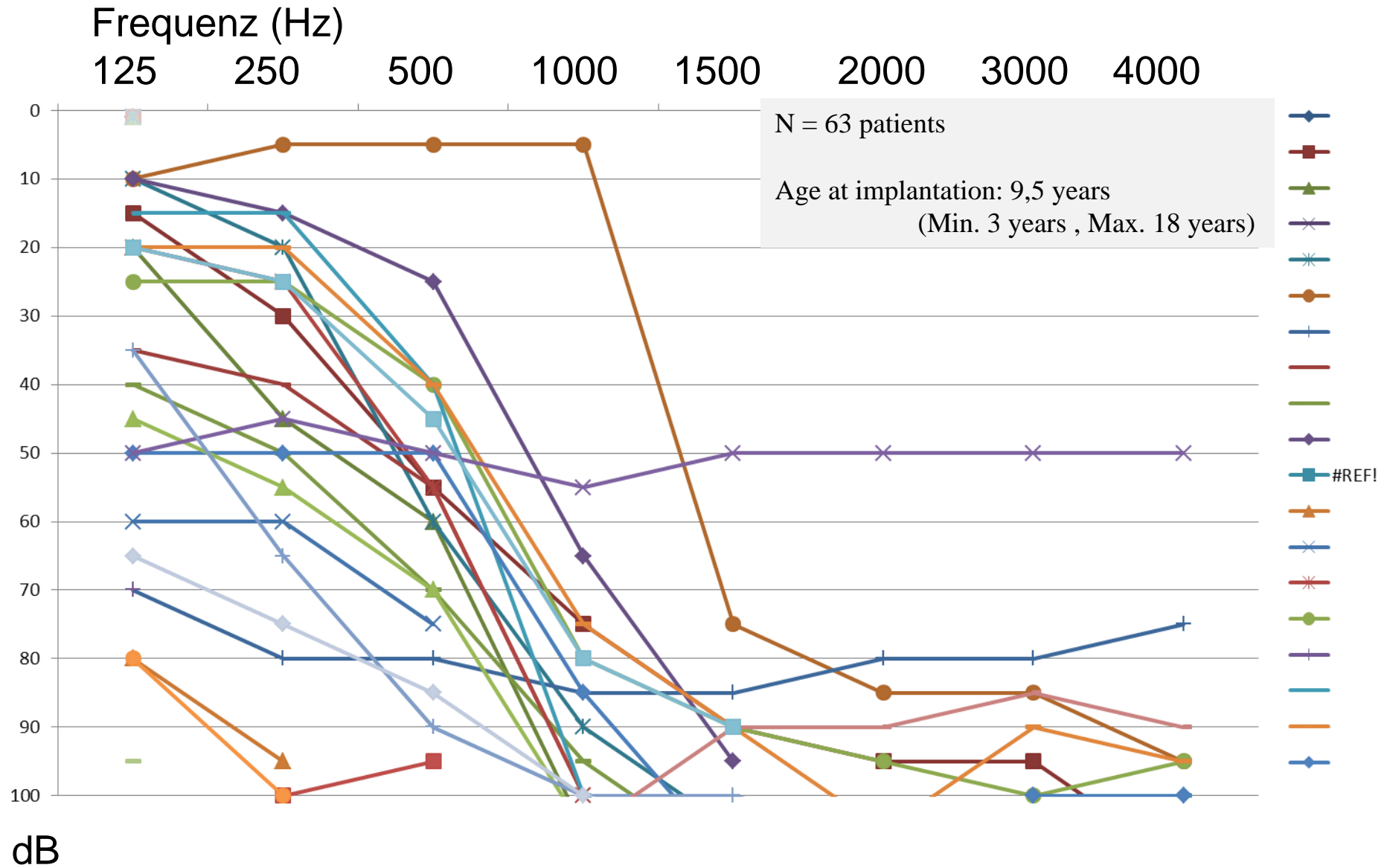
- residual hearing postop. -



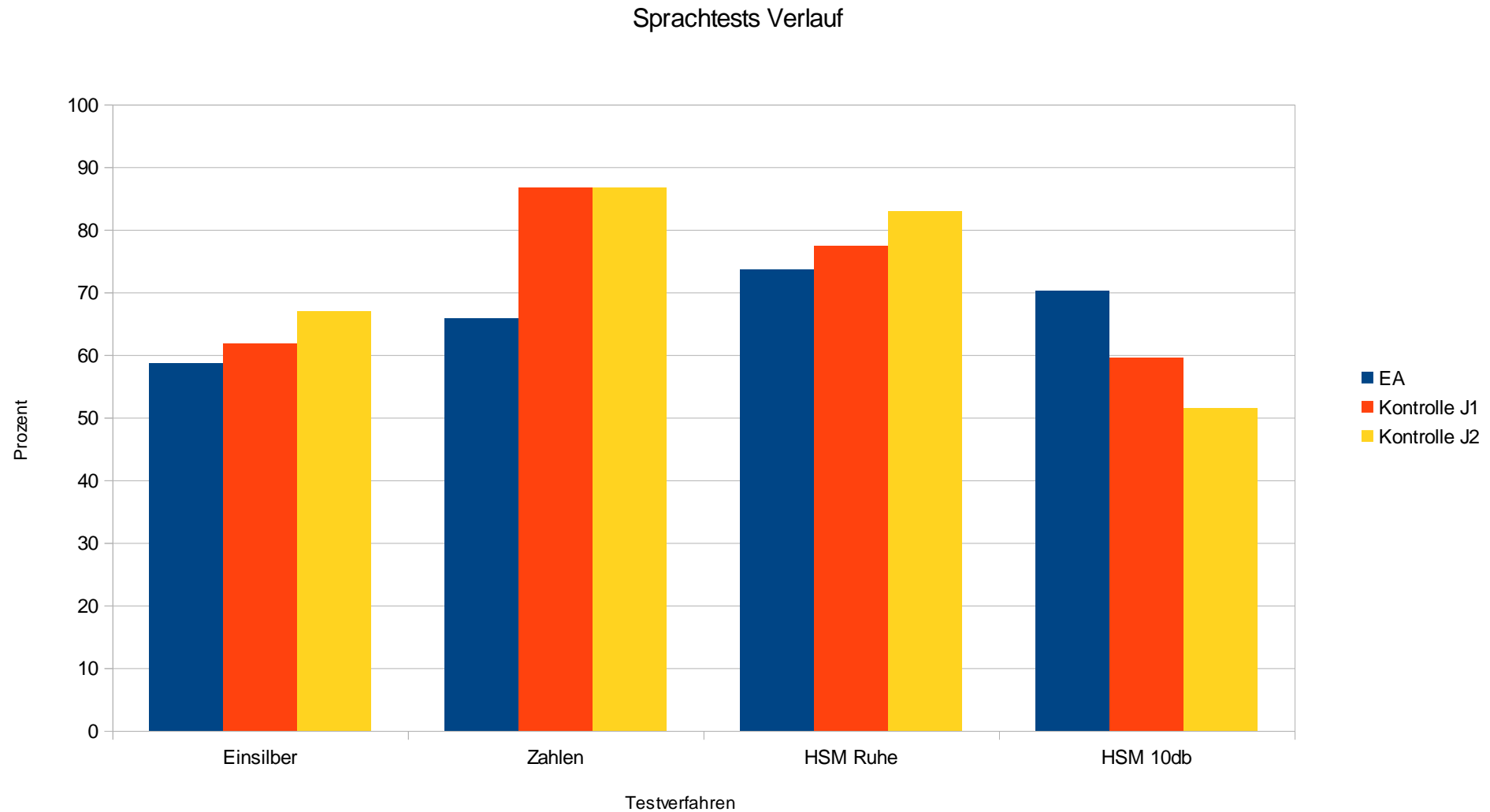
pure tone audiometry – preop -



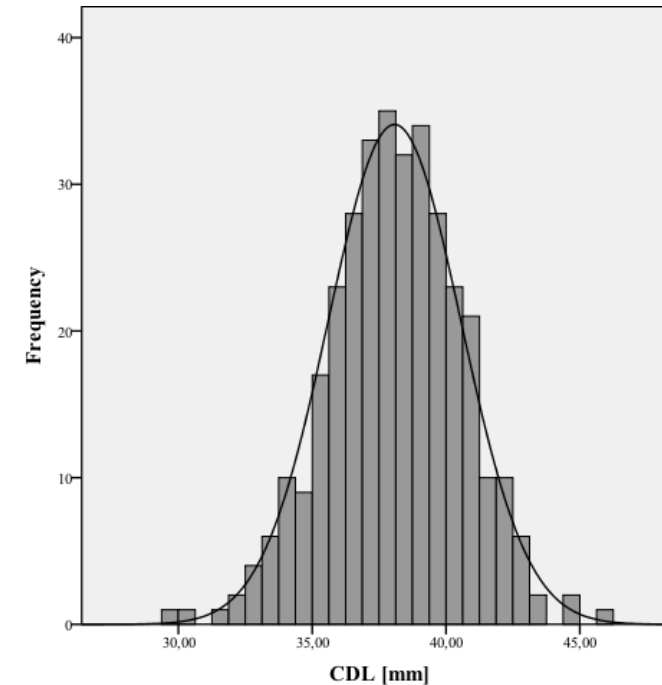
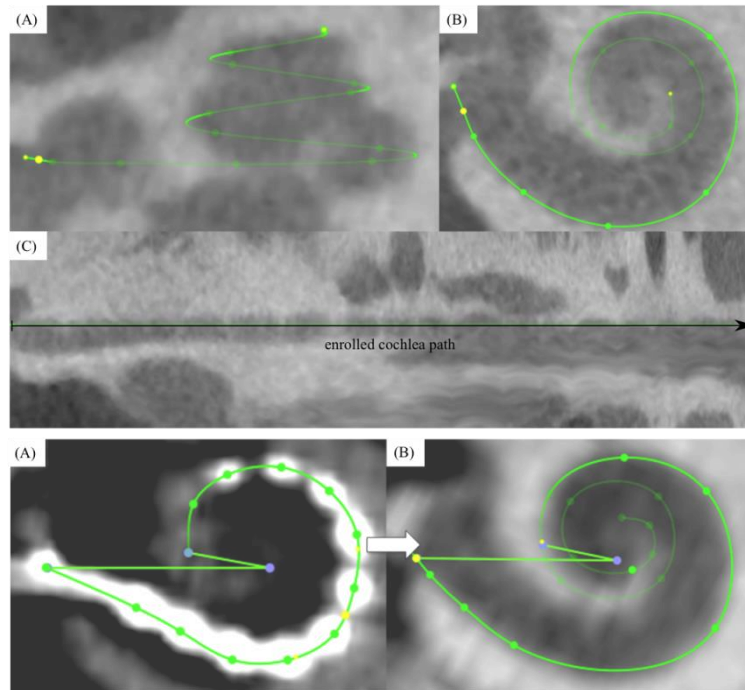
pure tone audiometry – 2 years postop -



Speech understanding after 2 years



Anatomical Indication Ranges



Measurements in 271 preop and 259 postop imaging datasets



RESEARCH ARTICLE

Patient specific selection of lateral wall cochlear implant electrodes based on anatomical indication ranges

Max Eike Timm*, Omid Majdani, Tobias Weller, Mayra Windeler, Thomas Lenarz, Andreas Büchner, Rolf Benedikt Salcher

Cluster of Excellence Hearing4all, Department of Otorhinolaryngology, Hannover Medical School, Hannover, Lower Saxony, Germany

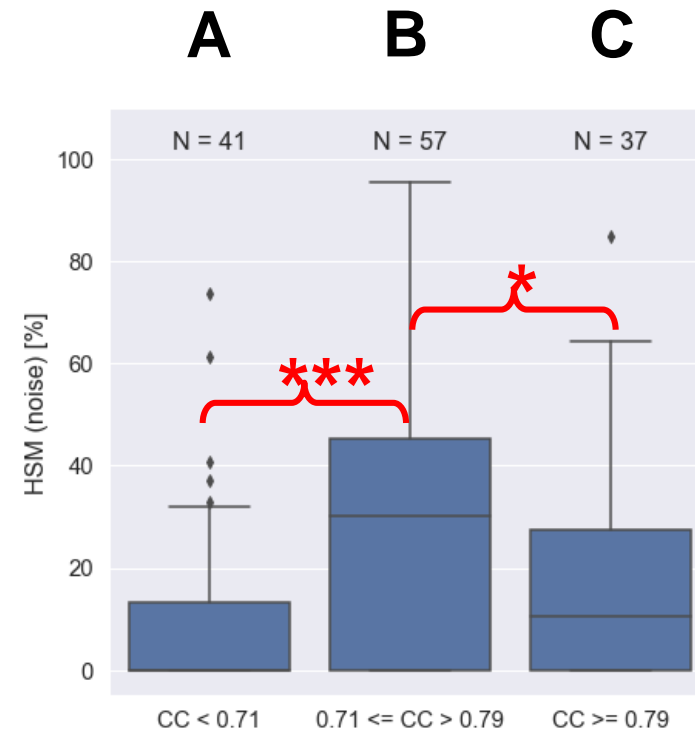
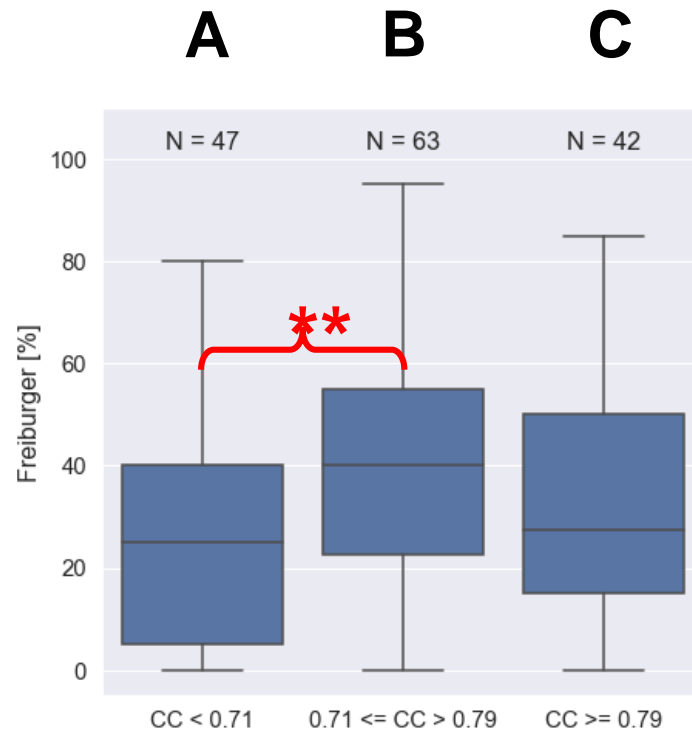
Otology & Neurotology
39:e642–e650 © 2018, Otology & Neurotology, Inc.

Analysis of Different Approaches for Clinical Cochlear Coverage Evaluation After Cochlear Implantation

*Daniel Schurzig, †Max Eike Timm, *Cornelia Batsoulis, ‡Samuel John, and †Thomas Lenarz

*MED-EL Medical Electronics, Hannover Research Center; †Cluster of Excellence Hearing4all, Department of Otolaryngology, Hannover Medical School; and ‡HörSys GmbH, Hannover, Germany

Cochlear Coverage vs. Speech Perception



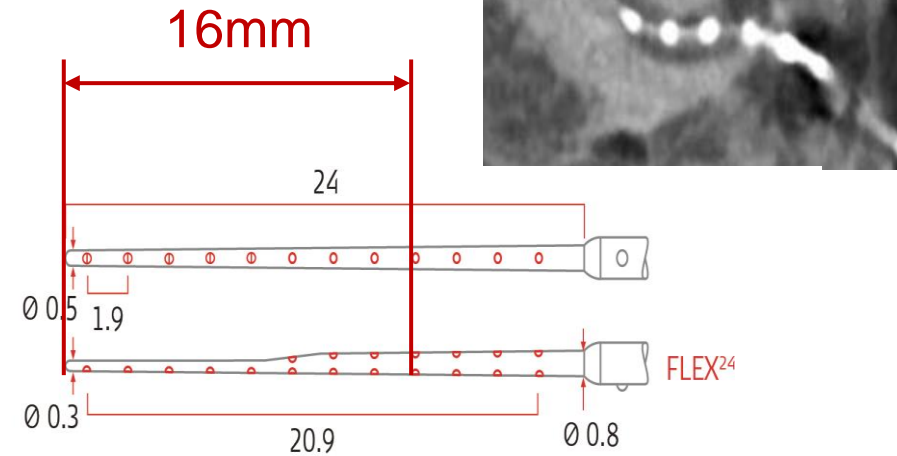
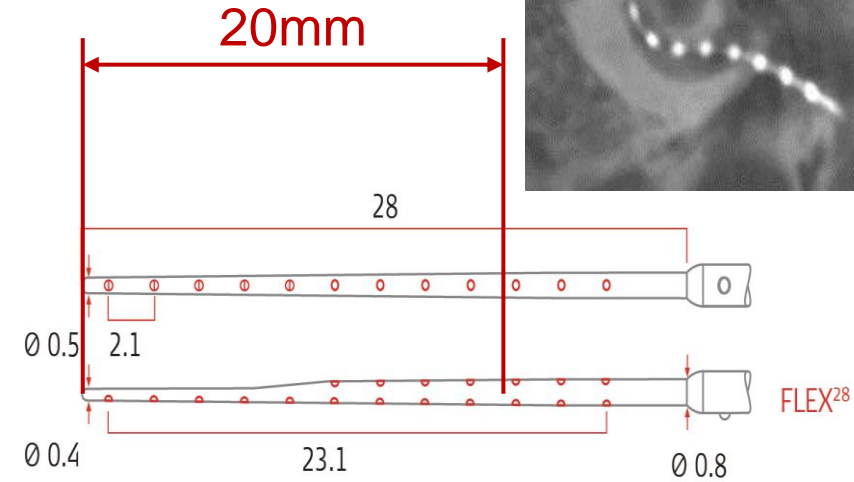
Wilcoxon test: * p < 0.05
 ** p < 0.01
 *** p < 0.001

New concept: Partial Insertion

Different treatment options:

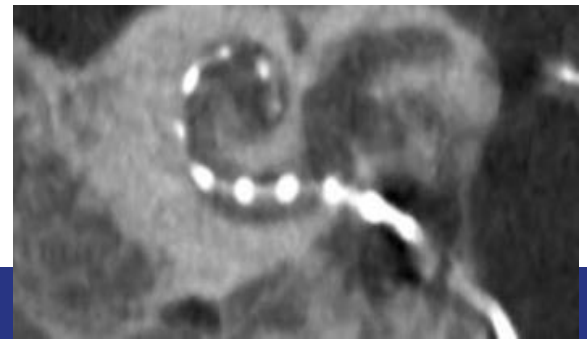
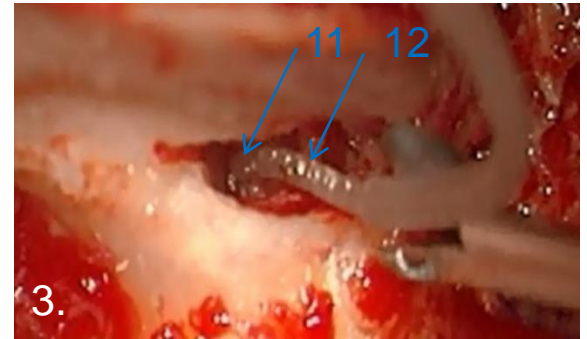
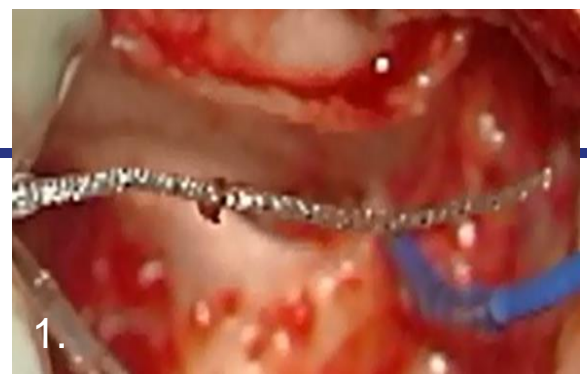
- 20 mm
 - FLEX28 to contact #10
 - N=3

- 16 mm
 - FLEX24 to contact #9
 - N=4

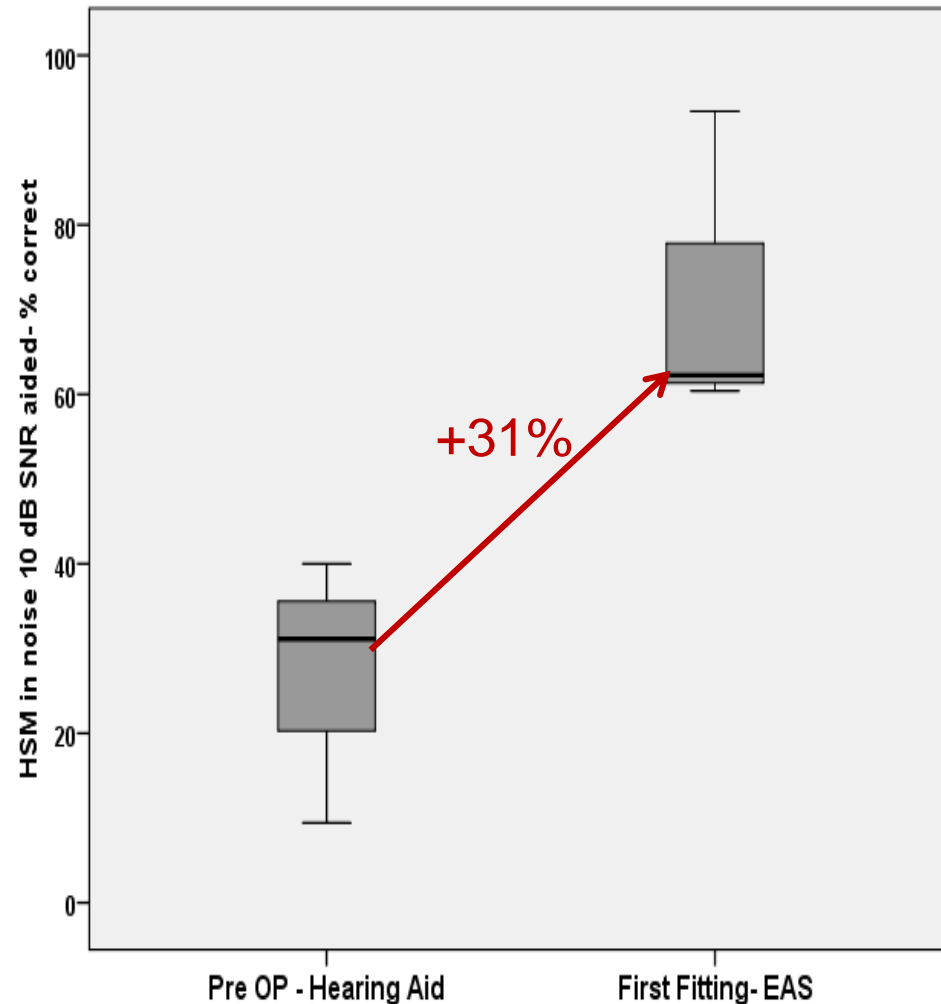


Surgical Procedure

1. Place fascia at contact #10, FLEX28
2. Very slow insertion is important to preserve residual hearing
3. Insert until fascia touches round window membrane
4. Fixation of electrode

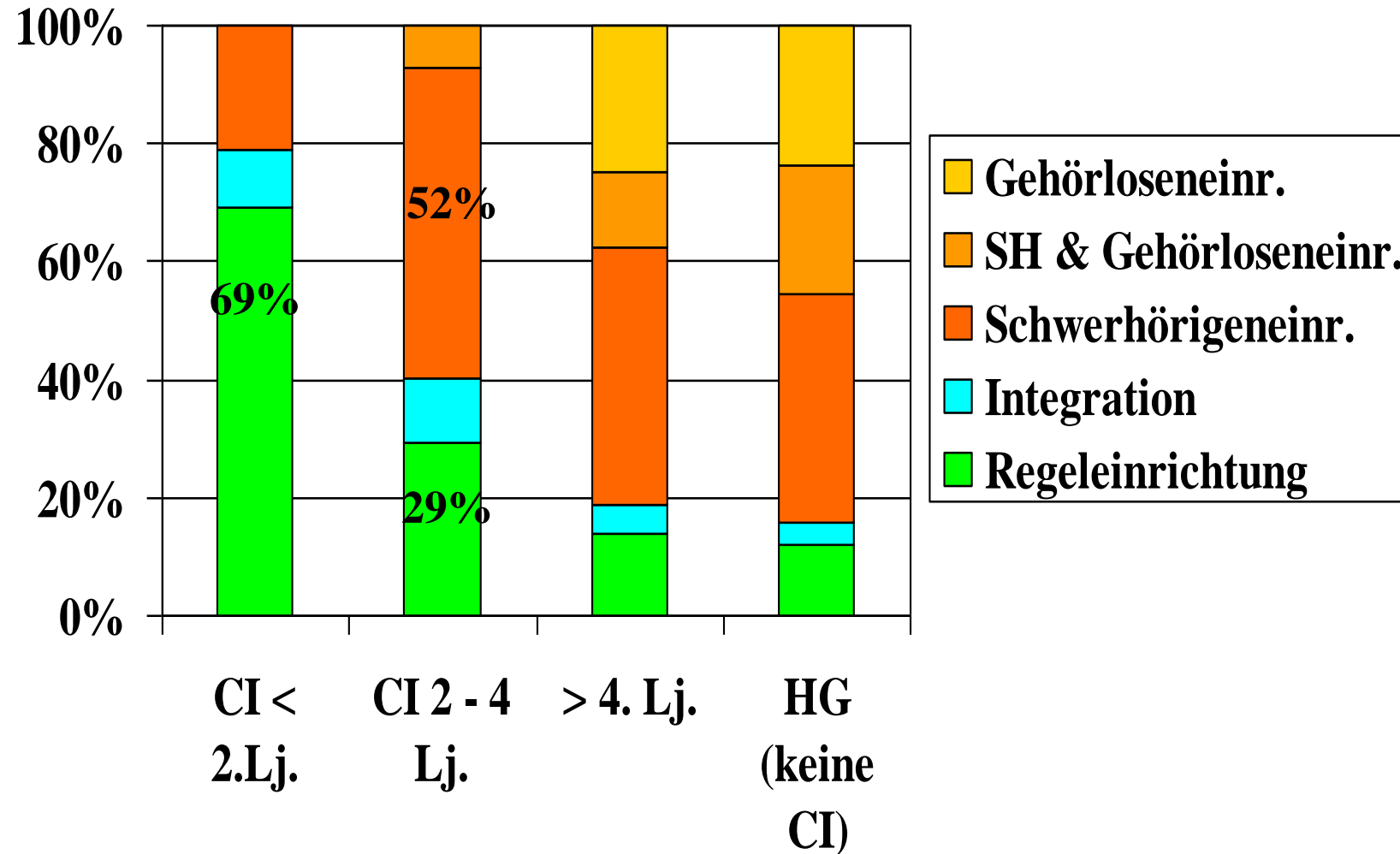


Speech perception in noise

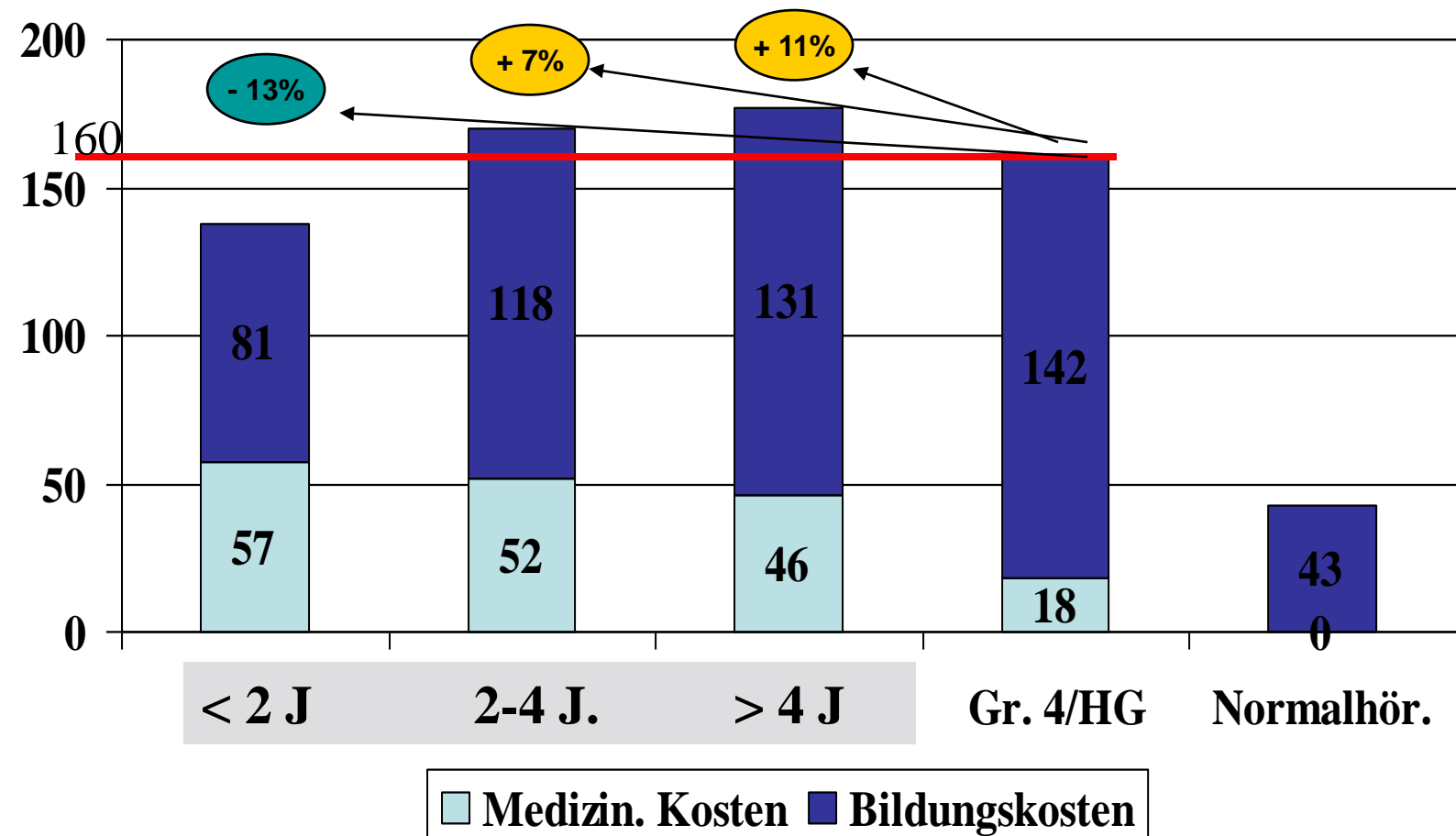


HSM in noise 10 dB SNR
N=3, **EAS** users postoperatively

Education abilities (published 1999)



Details of costs (published 1999)



Long-Term Outcomes, Education and Occupational Level in Cochlear Implant Recipients

[Illg A](#), [Haack M](#), [Lesinski-Schiedat A](#), [Büchner A](#), [Lenarz T](#): Long-Term Outcomes, Education, and Occupational Level in Cochlear Implant Recipients Who Were

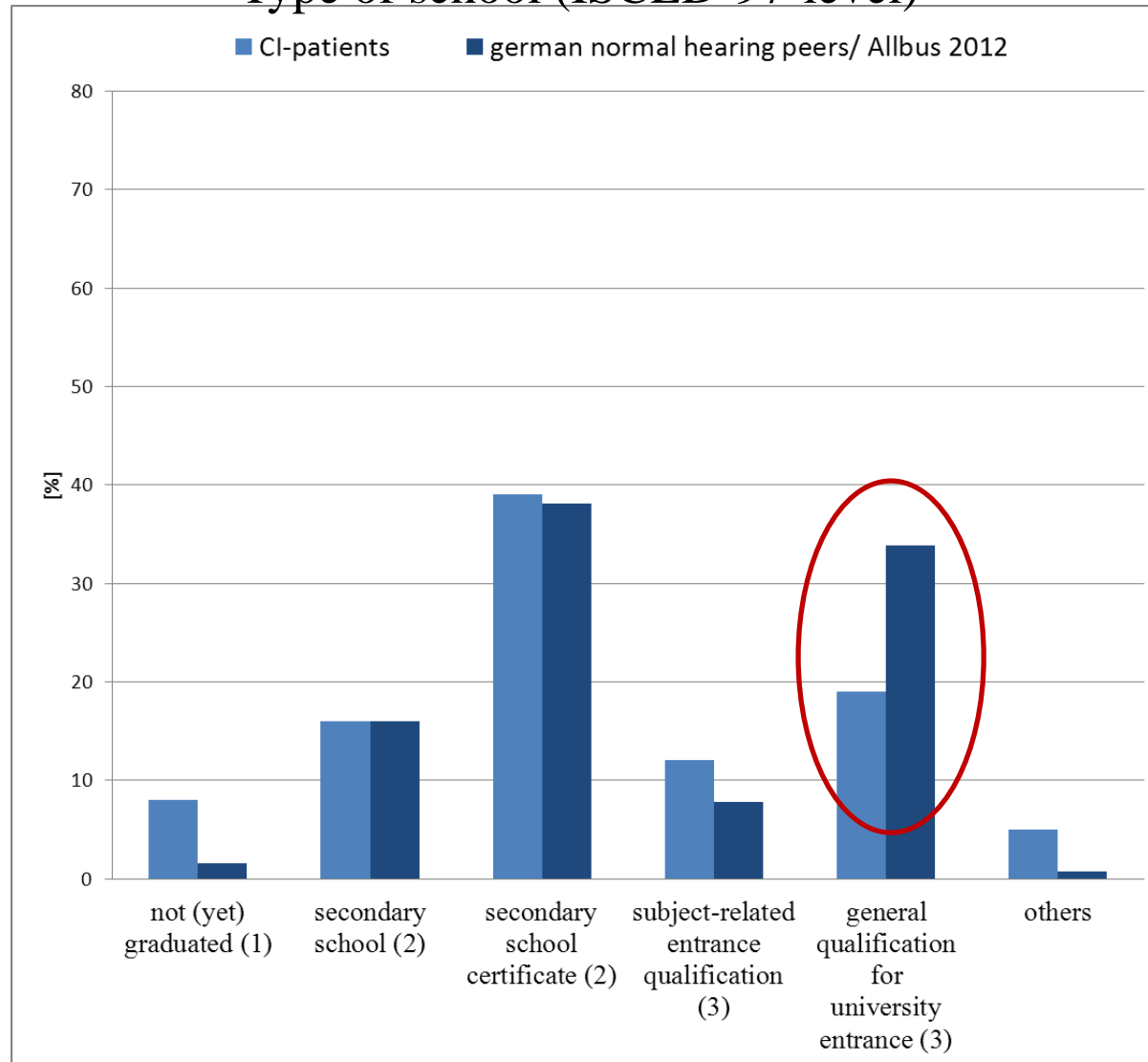
Implanted in Childhood. [Ear Hear.](#) 2017 Sep/Oct;38(5):577-587

Retrospective study

- patients: **N=933**
- Age at implantation: < 19 years (**between 1986 and 2000**)
- Outcome in 8 Categories of Auditory Performance (CAP) (Archbold et al. 1998)
- self-assessment-questionnaire with 8 categories:
 - living conditions and environment, therapy, educational background, school education, vocational training, occupation, job satisfaction and workplace
- Comparison of the data with national and international data of normal hearing peers
- Statistics: Kruskal-Wallis Test, Mann-Whitney-U Test, Spearman-Rho Correlationcoefficient

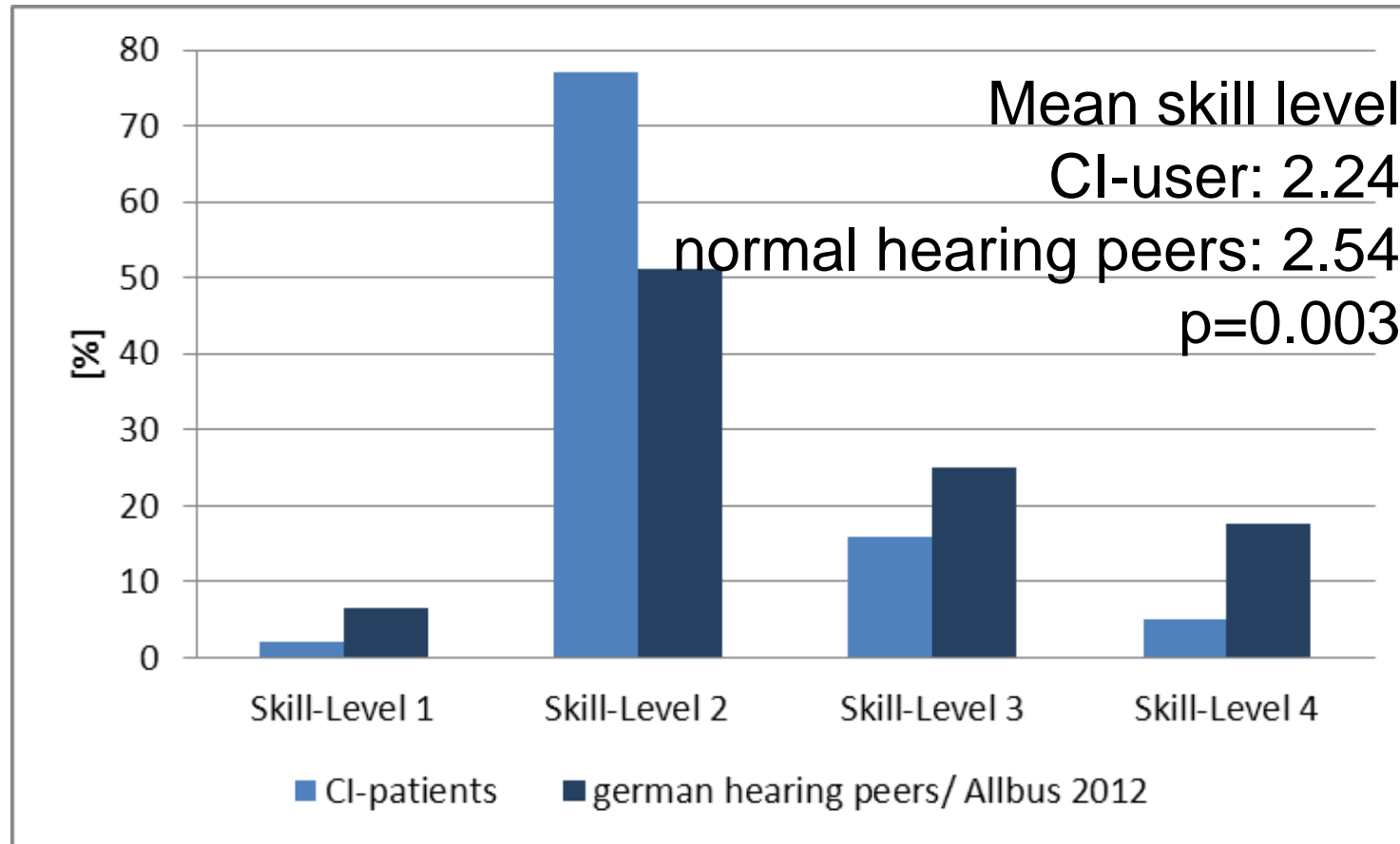
International Standard Classification of Education

Type of school (ISCED-97-level)



International Standard Classification of Occupation

ISCO-88 skill-levels

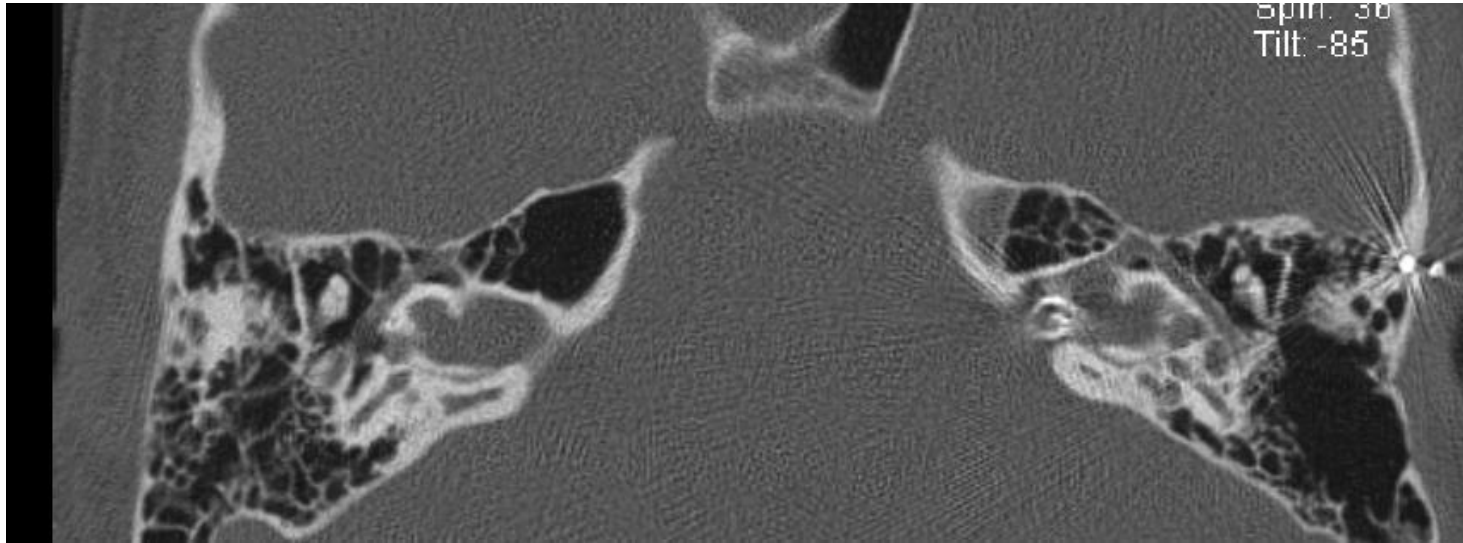


Example: to deep Insertion

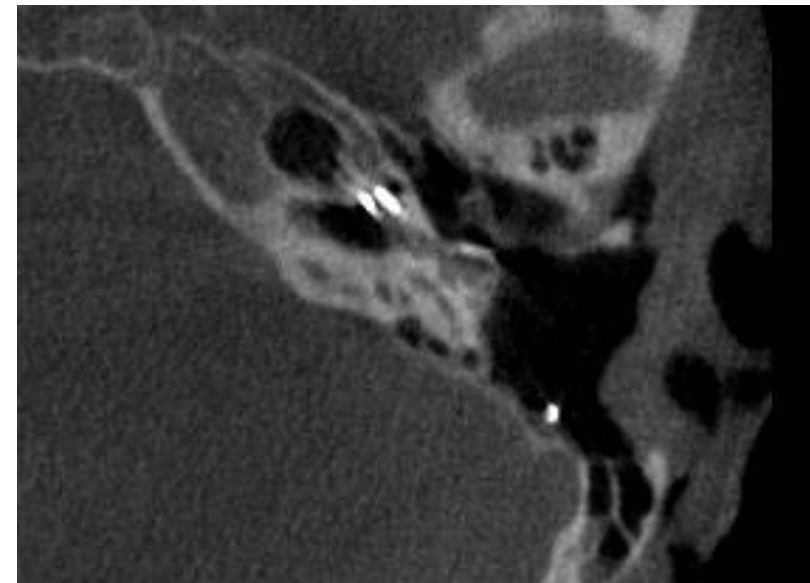
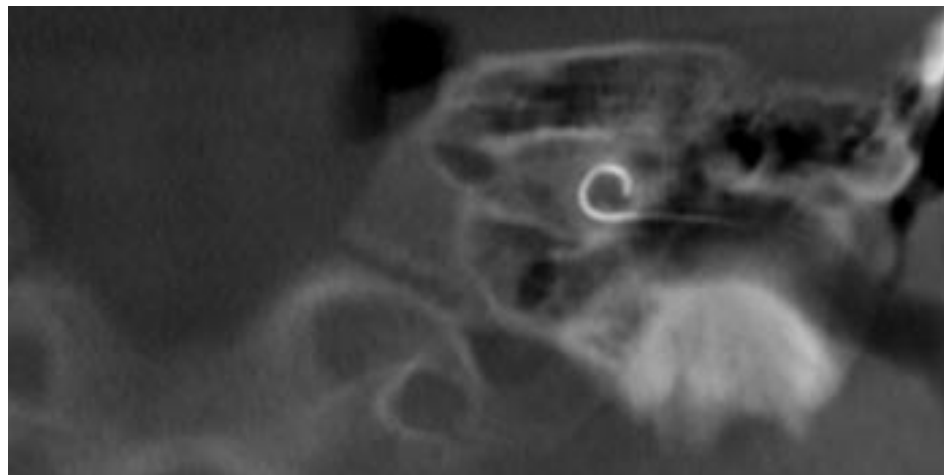


Example: Dysplasia

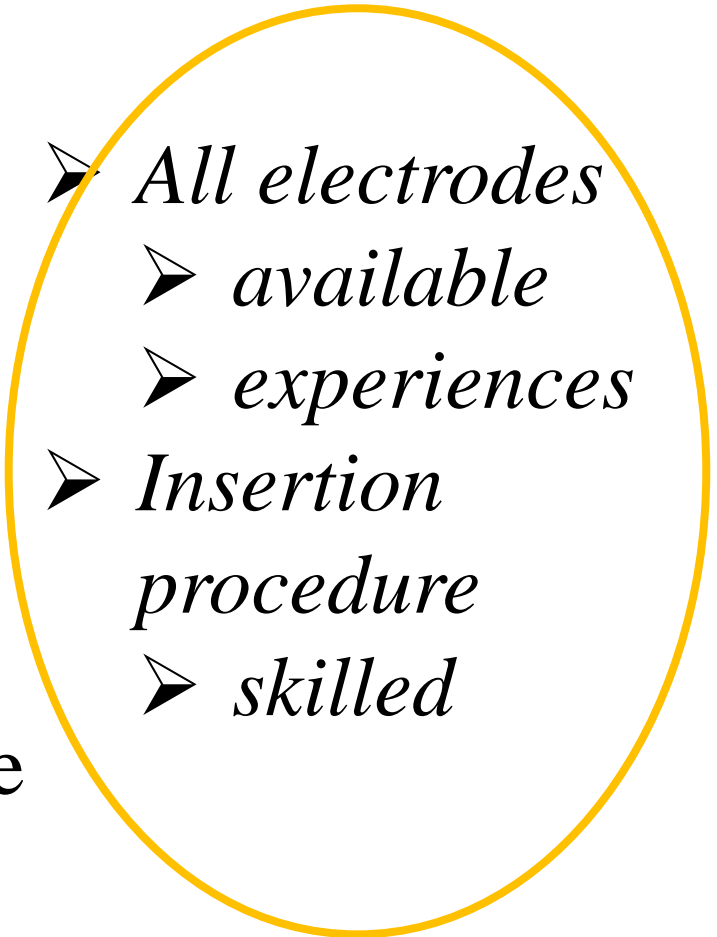
B.,B. *13.04.2022



Revision

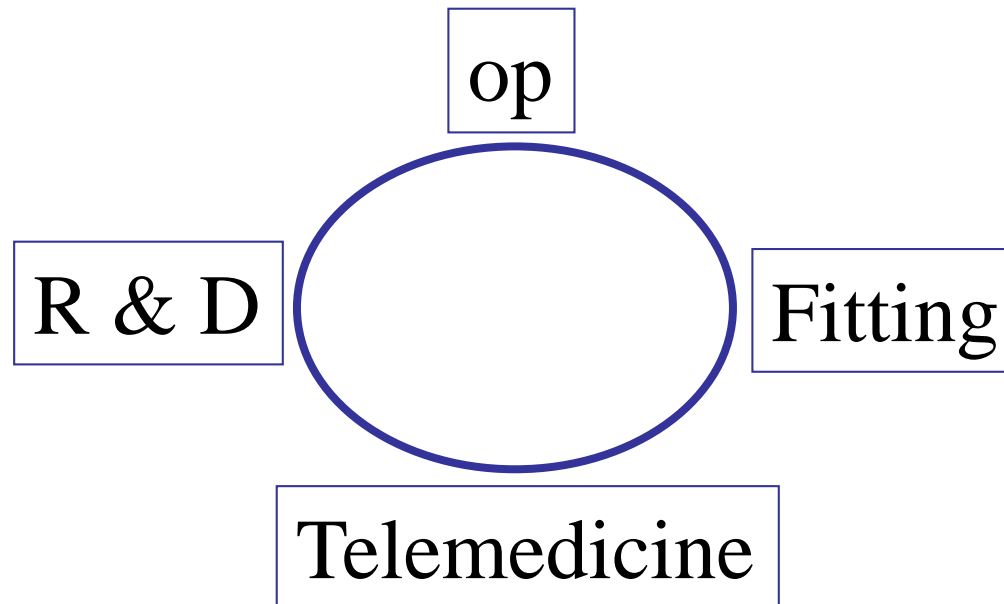


Challenges

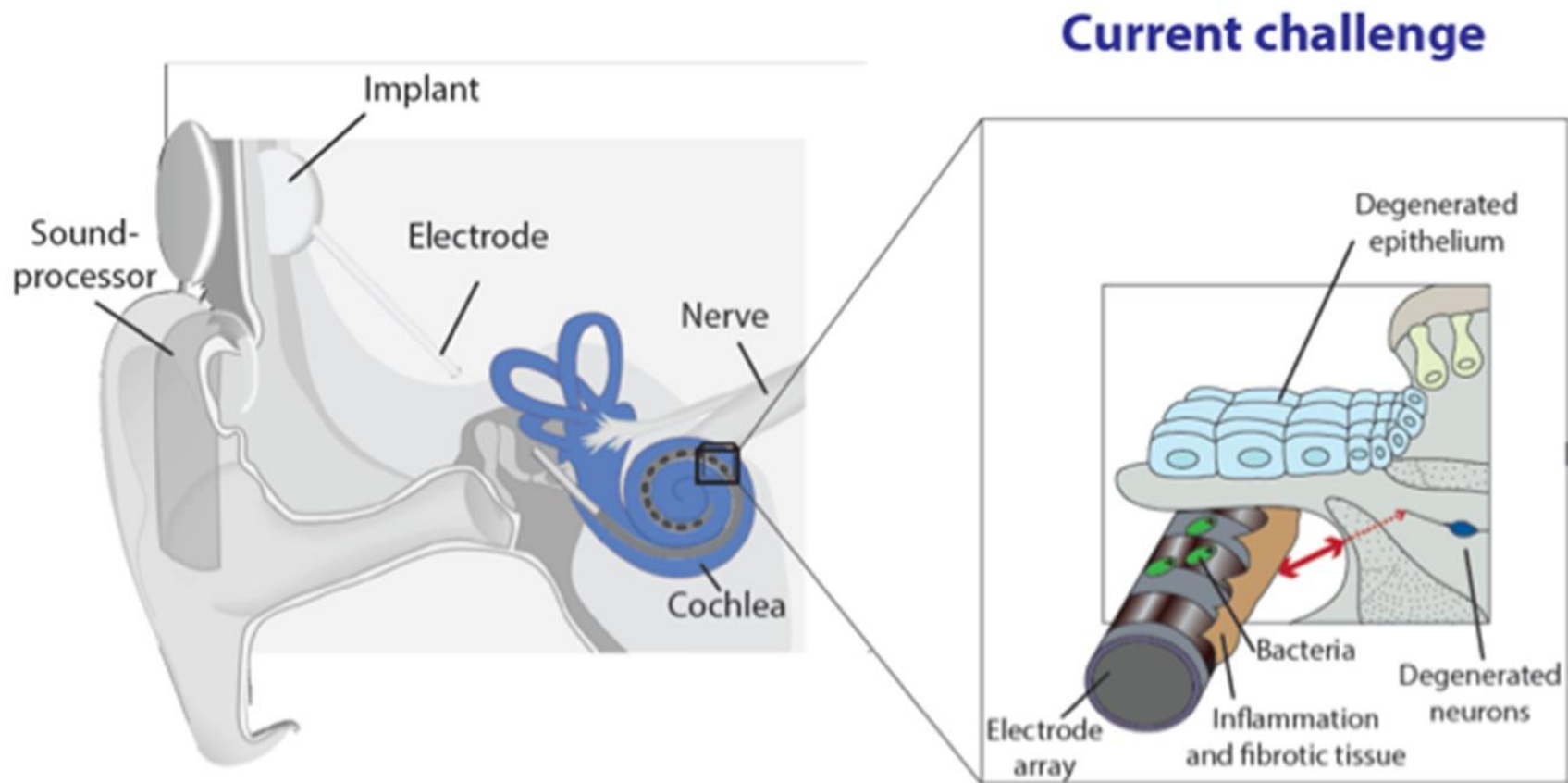
- Variety of electrodes
 - anatomy
 - length
 - residual hearing
 - Insertion procedure
 - intracochlear trauma
 - position
 - Electrophysiology ~ outcome
- 
- *All electrodes*
 - *available*
 - *experiences*
 - *Insertion procedure*
 - *skilled*

Longterm-Management, Fitting,

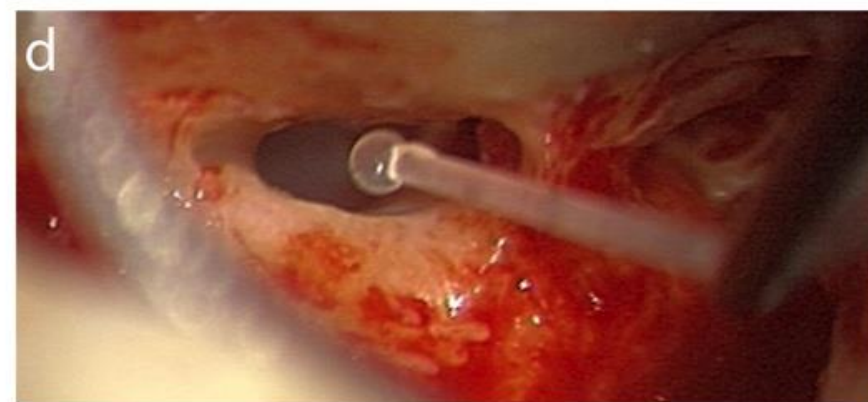
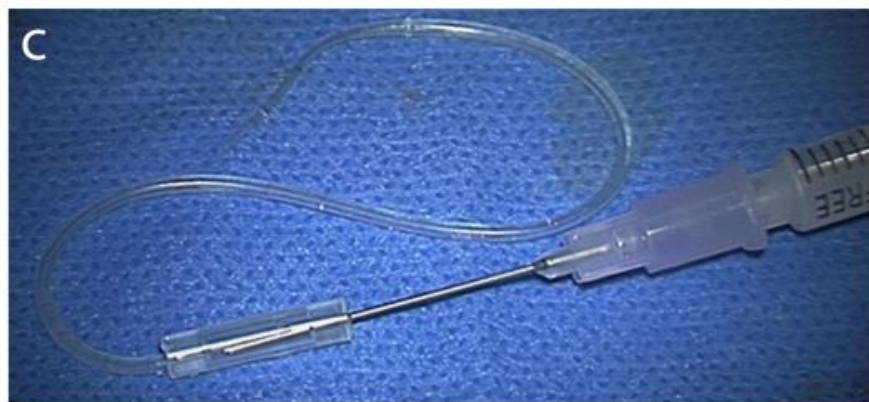
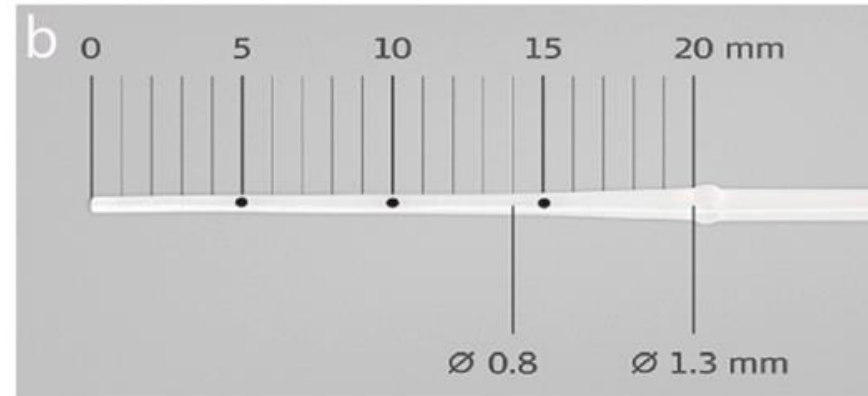
- „continuously ongoing“ expertise
- sufficient time for eCAP, Impedanz, Level, testing
- complicationen
 - Prevention
 - Early detection
- Neuroped. and / or other diagnostic ?



Focus on CI Therapy



Drug Delivery: Cochlear Catheter



Biohybrid-electrode in residual hearing

Römer et al. *Stem Cell Research & Therapy* _____
DOI 10.1186/s13287-016-0408-y

Stem Cell Research & Therapy

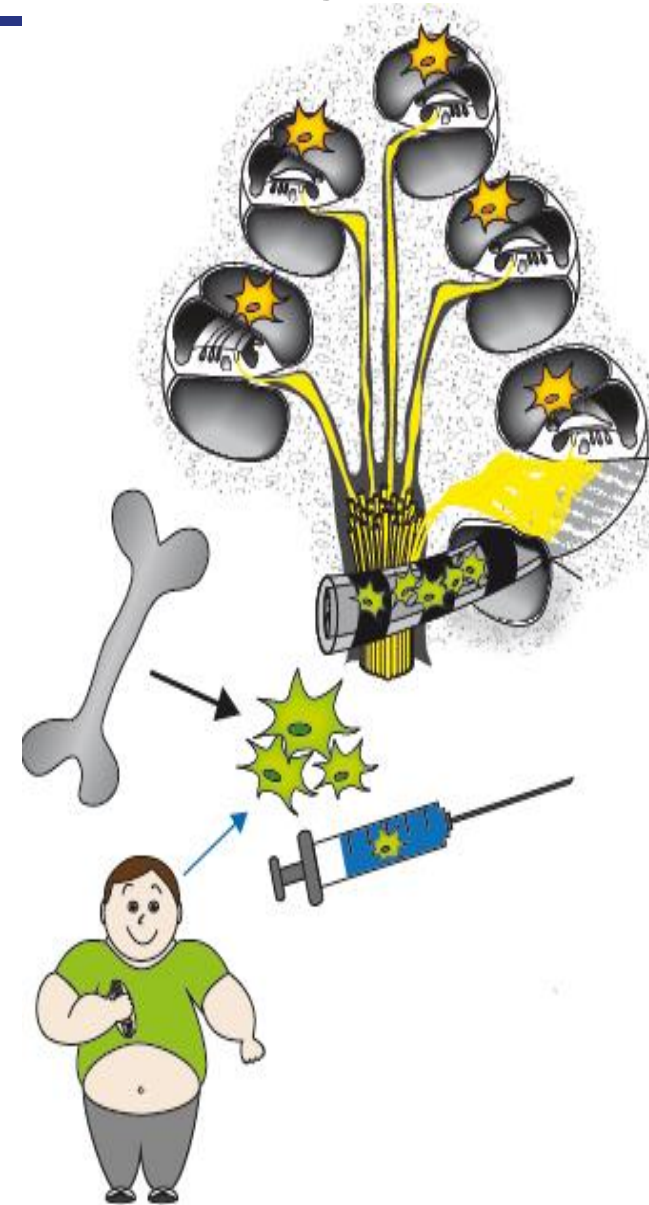
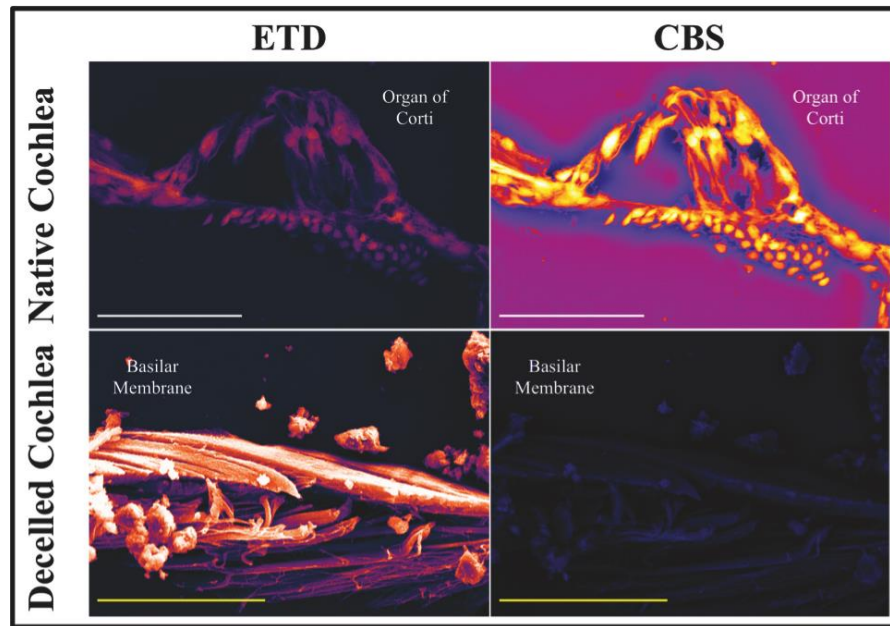
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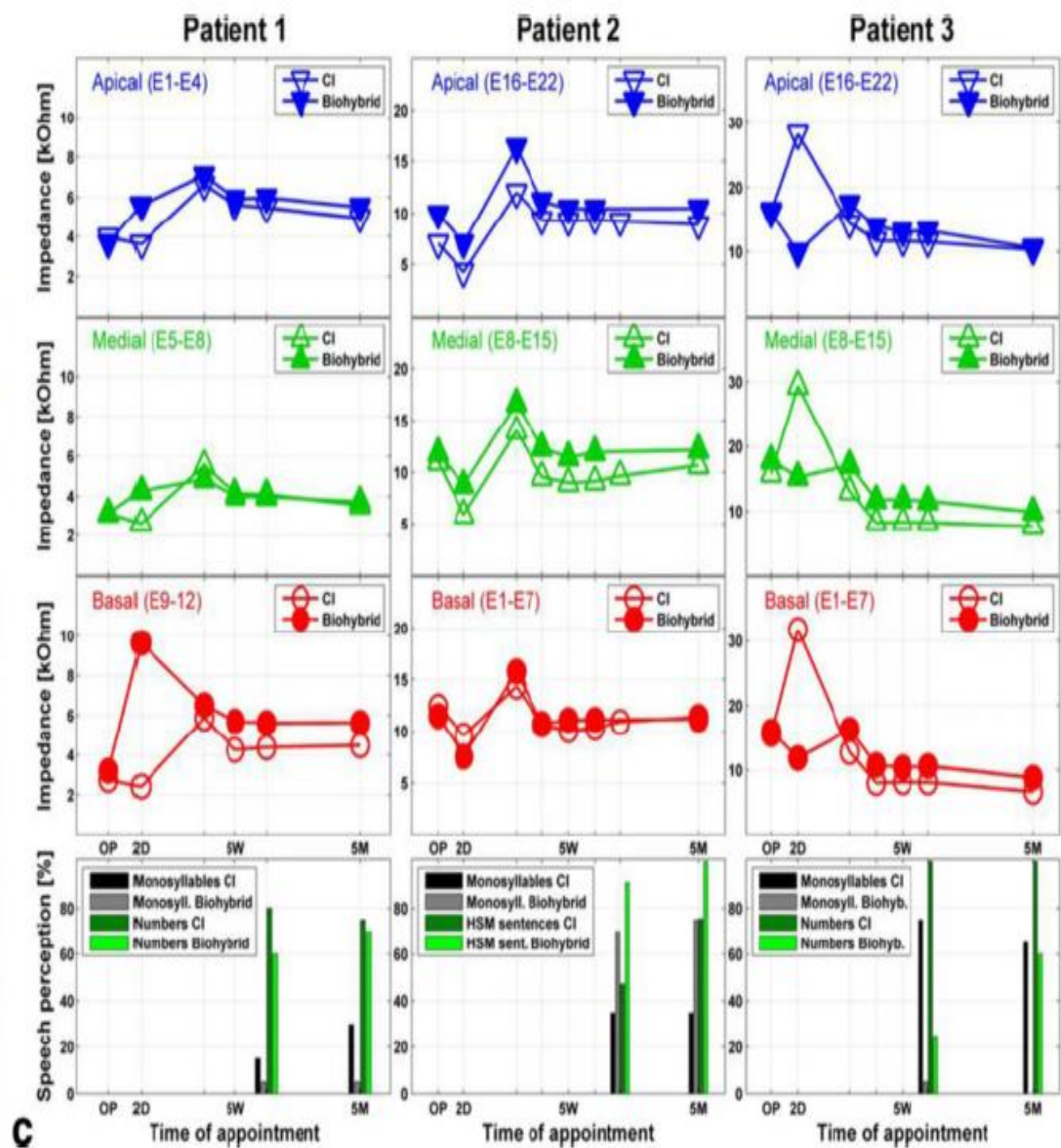
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Biohybrid cochlear implants in human neurosensory restoration



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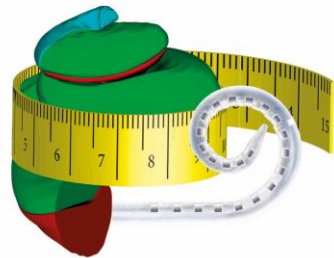
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Cochlea-Implantate-maßgeschneidert

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30625 Hannover



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