ゆりかごから
グランド・ジェネレーションまで

–聴覚のメカニクスを医療・福祉・スポーツへ–

仙台高専　濱西伸治

Shinji HAMANISHI

Department of Mechanical Engineering,

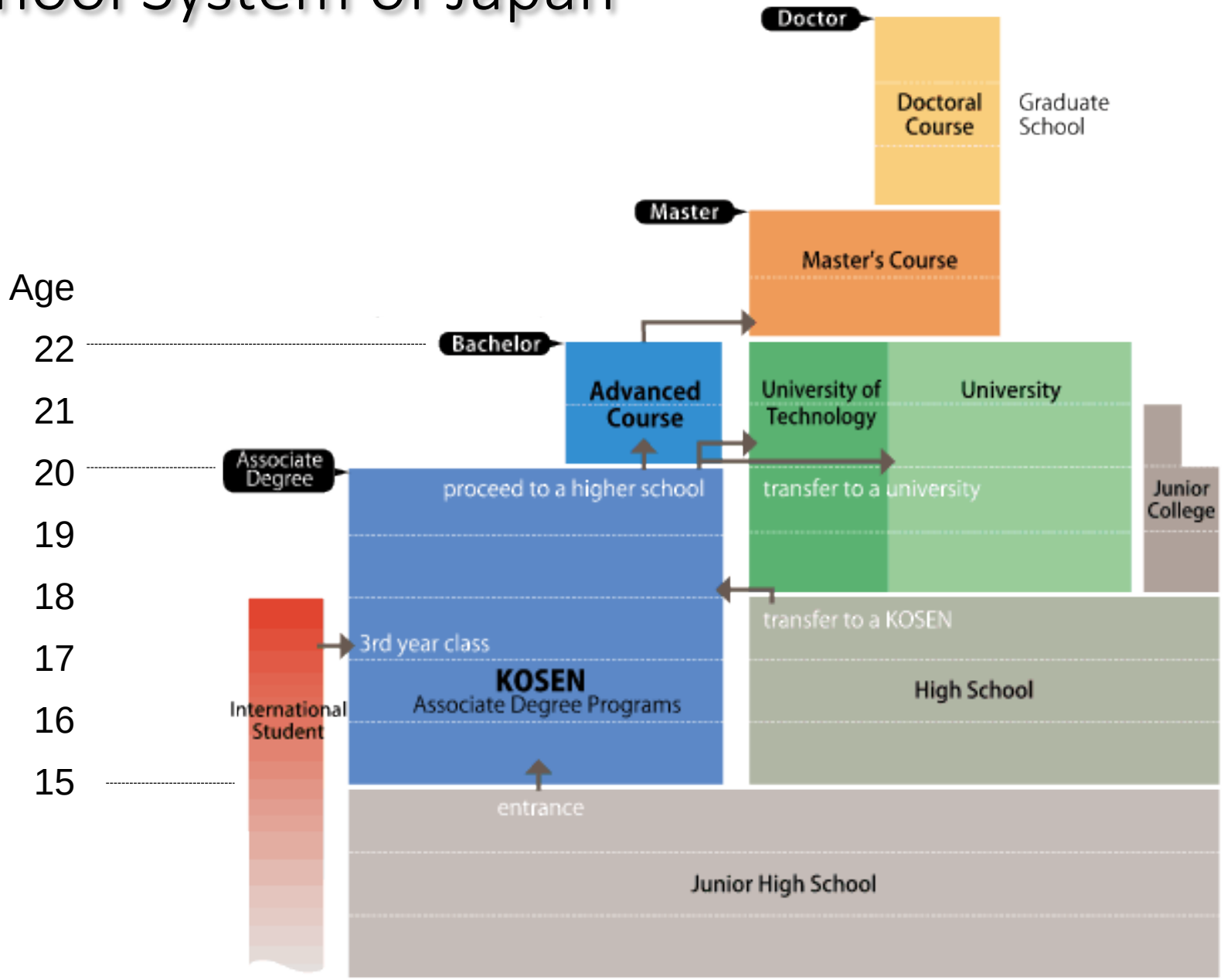
Sendai National College of Technology

Profile

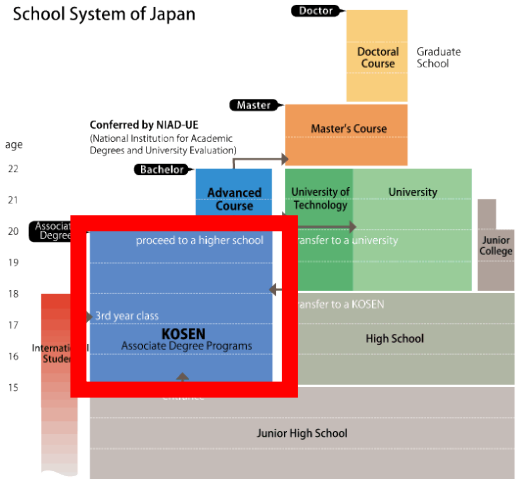
Instruction at Stanford, USA (2013)

- Born in Toyama
- Kendo 6-Dan
- Tohoku University, Sendai (-2006)
- Sendai National College of Technology (2006-present)
- Stanford University, USA (2013, Visiting Associate Prof.)

School System of Japan



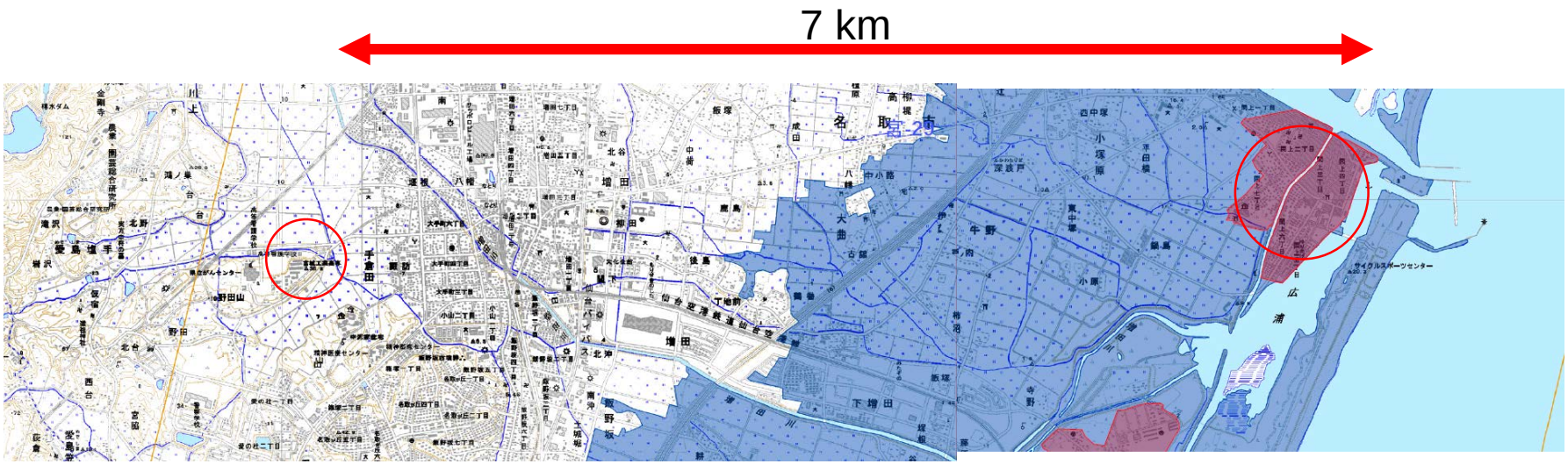
KOSEN
(Colleges of Technology)



- Five-year engineering education from 15 years old
- The first KOSEN was established in 1961
- 51 national KOSEN in Japan.
- Approximately 300,000 students have graduated

March 11th, 2011

“TSUNAMI” area



研究テーマ

聴覚のメカニクスの解明と
医療・福祉・スポーツ分野への
応用研究

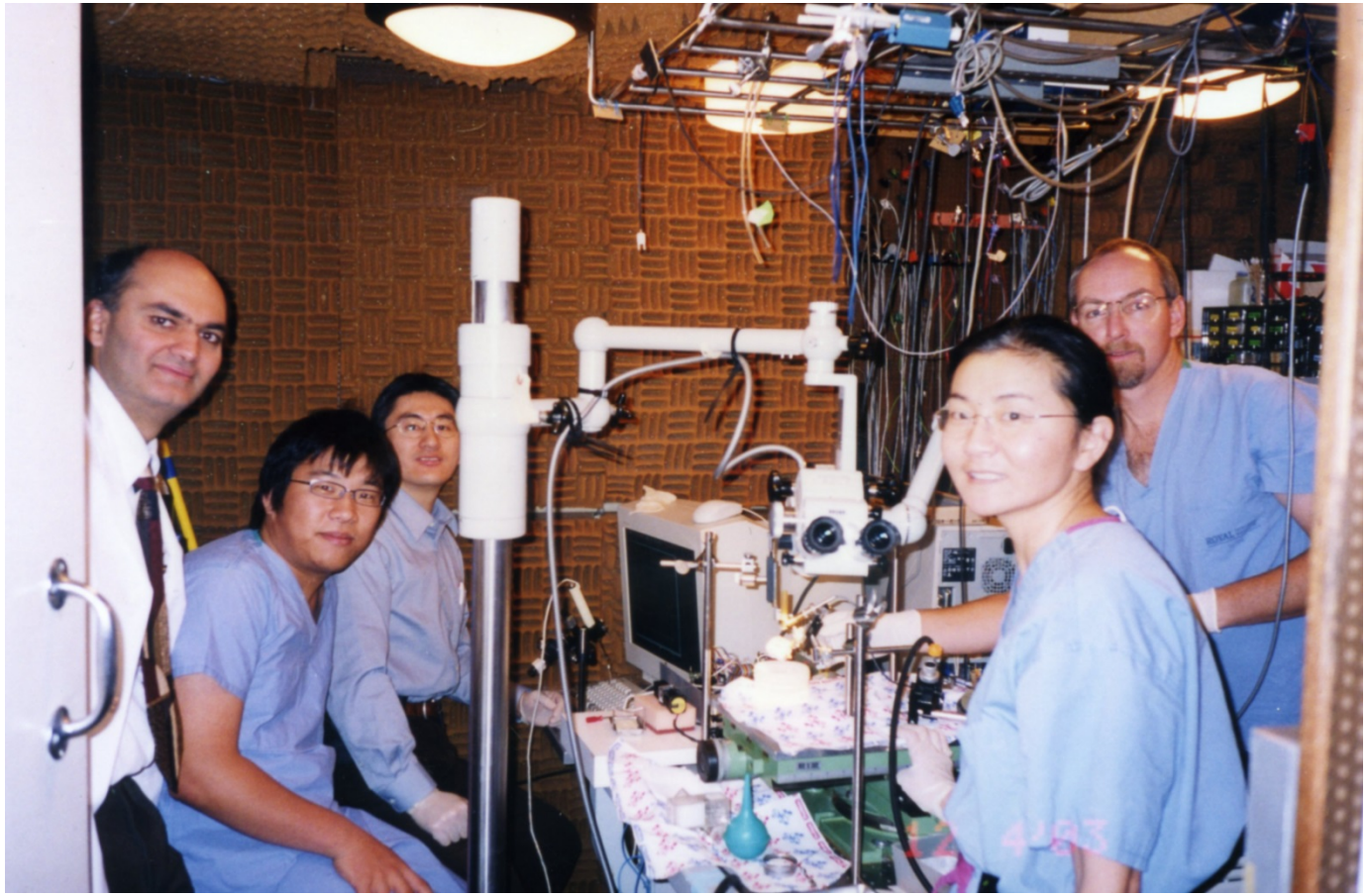
“Think globally, act locally”

2015 July 1st–5th Aalborg, Denmark

MEMRO

7th International Symposium on Middle Ear Mechanics in Research and Otology

“Think globally, act locally”



Massachusetts Eye and Ear Infirmary (Boston, USA) にて実験(2003)

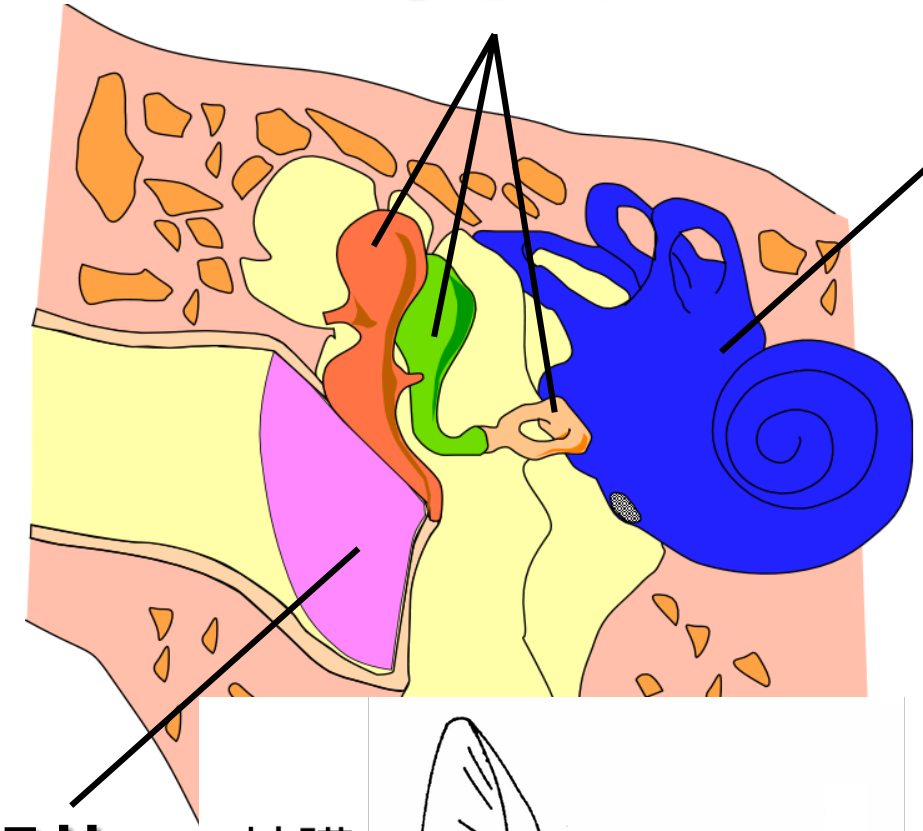
シンクロナイズドスイミング

2015年7月24日　朝日新聞

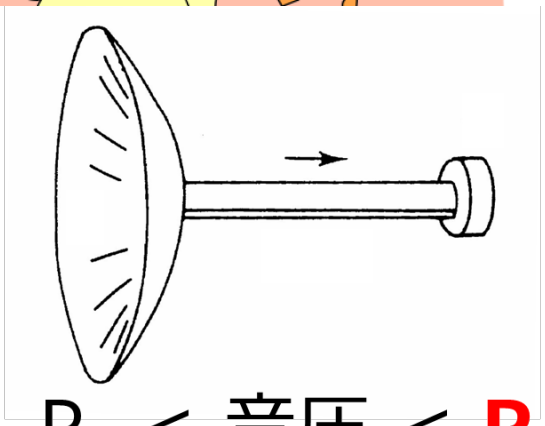
ヒトの聴覚器官

耳小骨

かぎゅう
蝸牛



鼓膜



P_1 < 音圧 < P_2

Topic 1

赤ちゃんは，自身で聴こえを
意思表示することができません.

聴こえをどのように診断しますか？

(1) 新生児耳疾患スクリーニング装置の開発

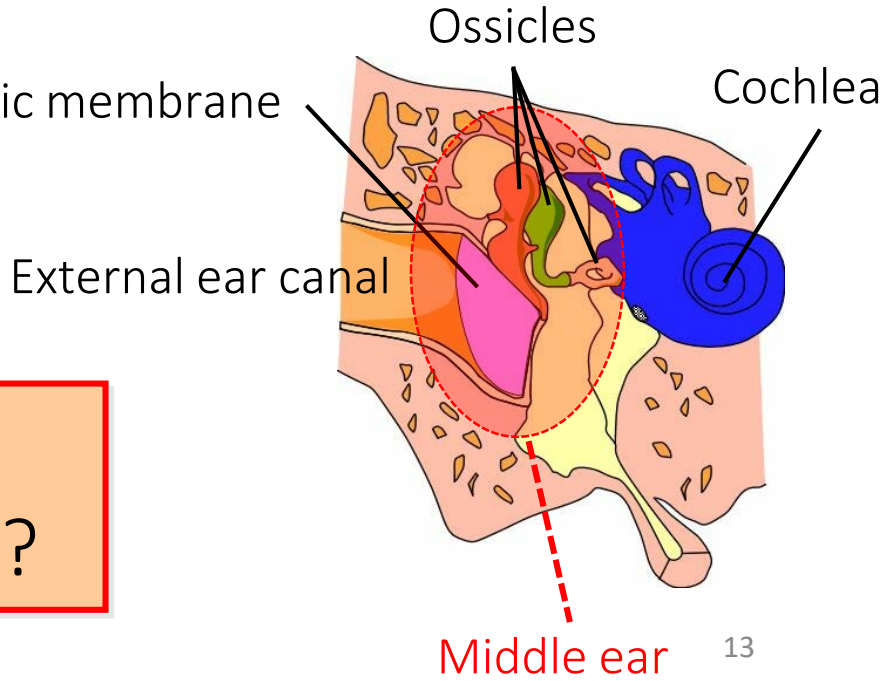
新生児耳疾患スクリーニング装置の開発

科研費（基盤研究C）16K11194 *共同研究者

- Hearing disorders occur in about 1-2 out of 1,000 neonates.
  (Morton and Nance, 2006)

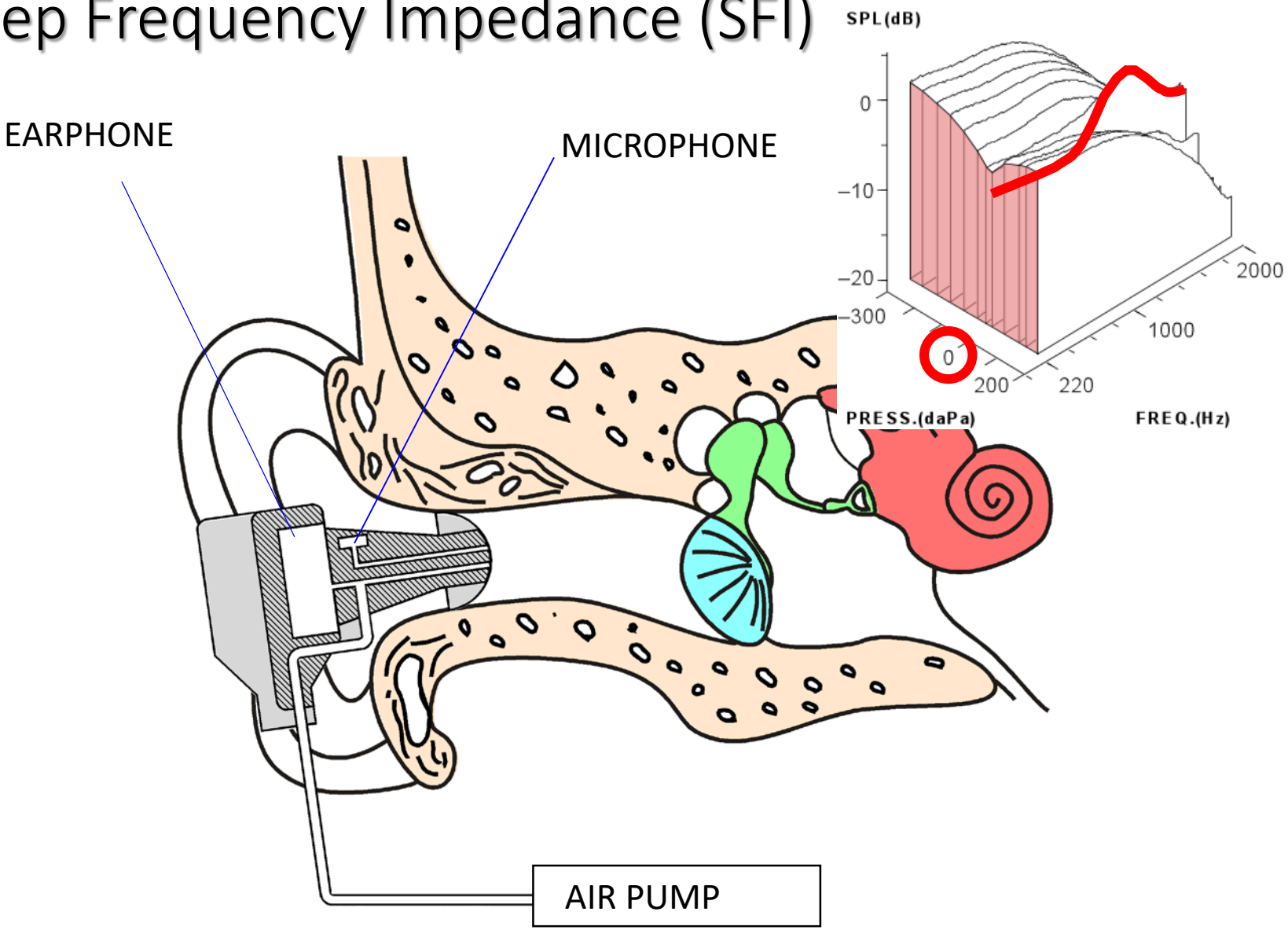
MADSEN AccuScreen

- Automated ABR
- OAE



Conductive hearing loss ?
Sensorineural hearing loss ?

Sweep Frequency Impedance (SFI)



Probe tone frequency from 200 to 2000 Hz

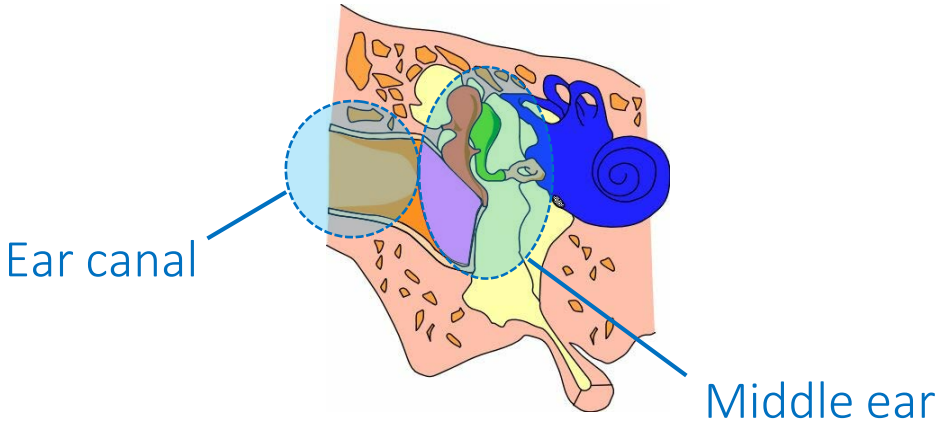
Static pressure from +200 to -200 daPa

Sweep Frequency Impedance (SFI) meter

US Patent 5063946

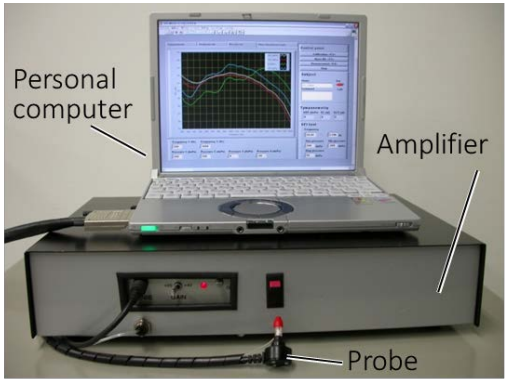
Wada, Koike *et al*., 1998

Purpose



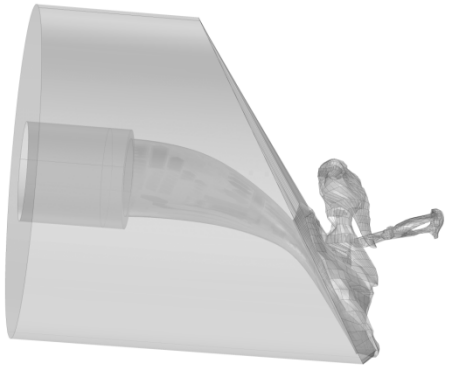
Effects of maturation on dynamic behavior

Sweep Frequency Impedance (SFI) meter



Murakoshi, Hamanishi, Wada *et al*., 2013

SFI tests (～5 months)



FE model for neonatal external & middle ear

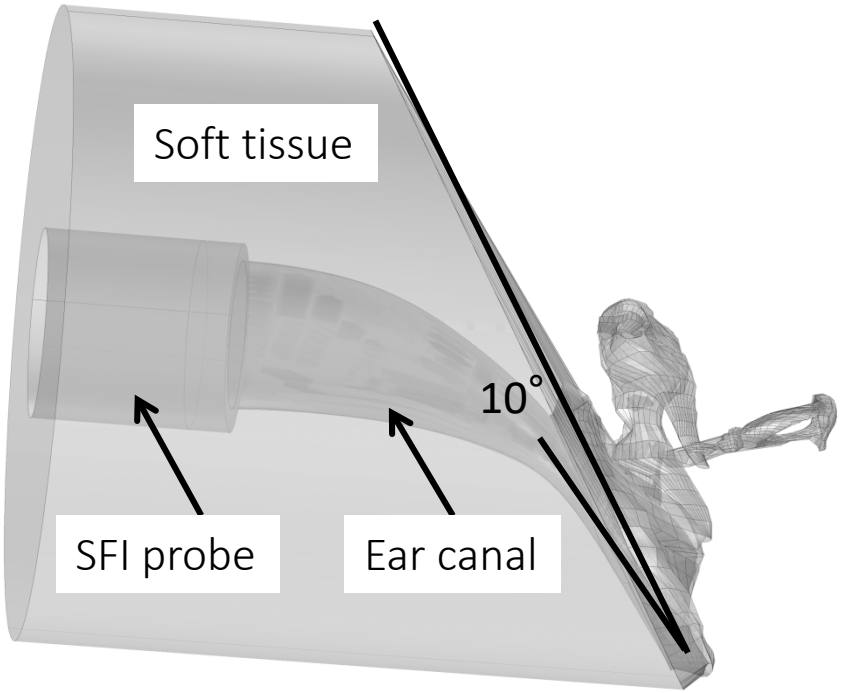
Chronological study (SFI test)

Subject	Neonate A	Neonate B
Sex	female	male
Gestational age	41 weeks	40 weeks
Chronological ages	6 to 92 days	9 to 143 days
Birth weights	3,054 g	3,312 g

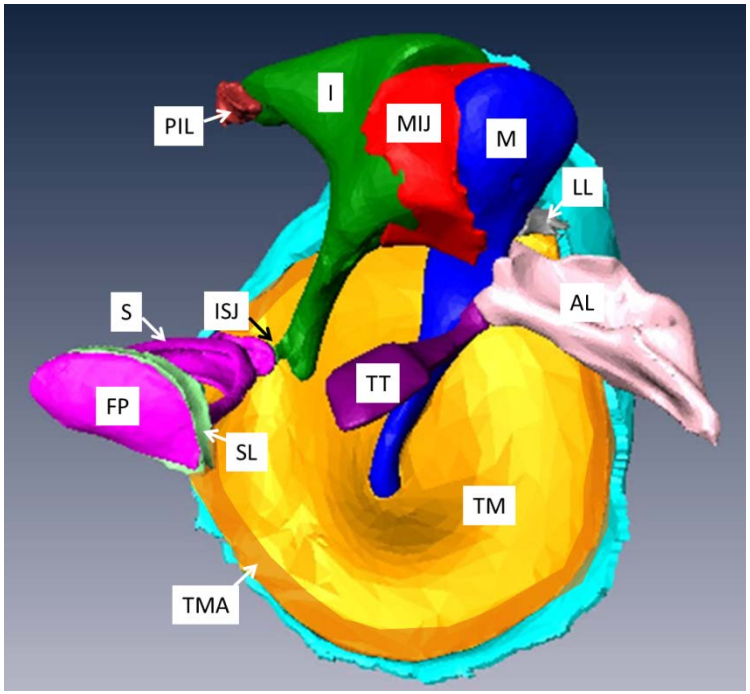
This study was approved by the Ethics Committee on Clinical Investigation, Tohoku University School of Medicine, and was performed in accordance with the policy of the Declaration of Helsinki.

FE computational model of neonatal ear

(a)

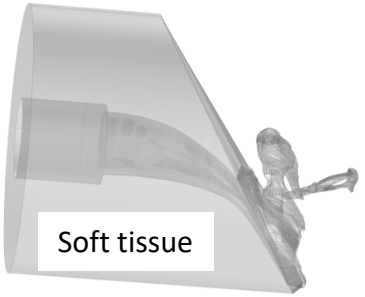


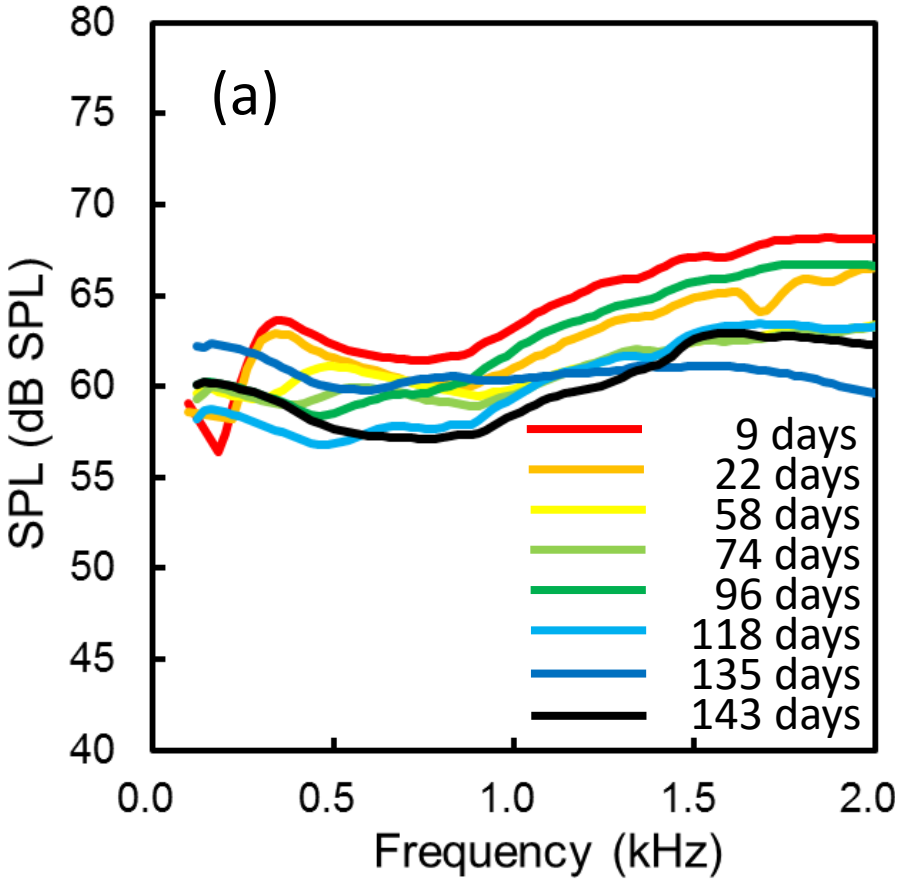
(b)

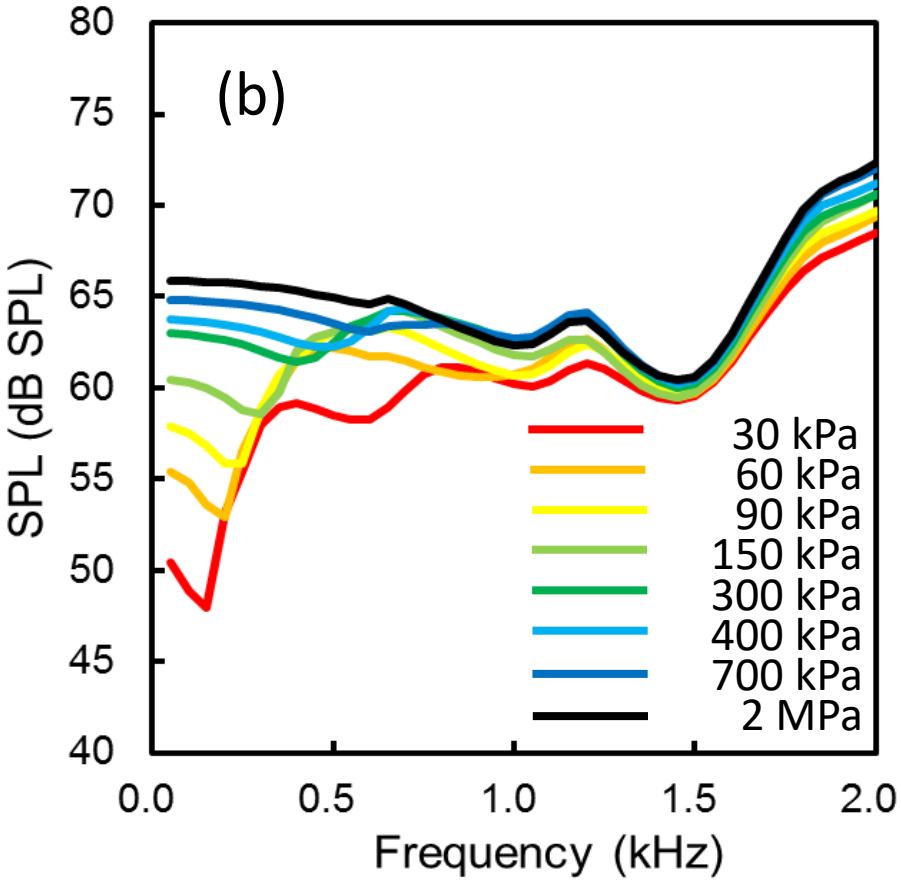


(a) Model mesh of a left human middle-ear structures with neonatal external ear canal. (b) Middle ear includes the malleus (M), incus (I), stapes (S), malleus-incus joint (MIJ), incudostapedial joint (ISJ), footplate of the stapes (FP), tympanic membrane (TM), tensor tympani tendon (TT), anterior ligament of the malleus (AL), lateral ligament of the malleus (LL), posterior incus ligament (PIL), stapes annular ligament (SL), and tympanic membrane annular ligament (TMA).

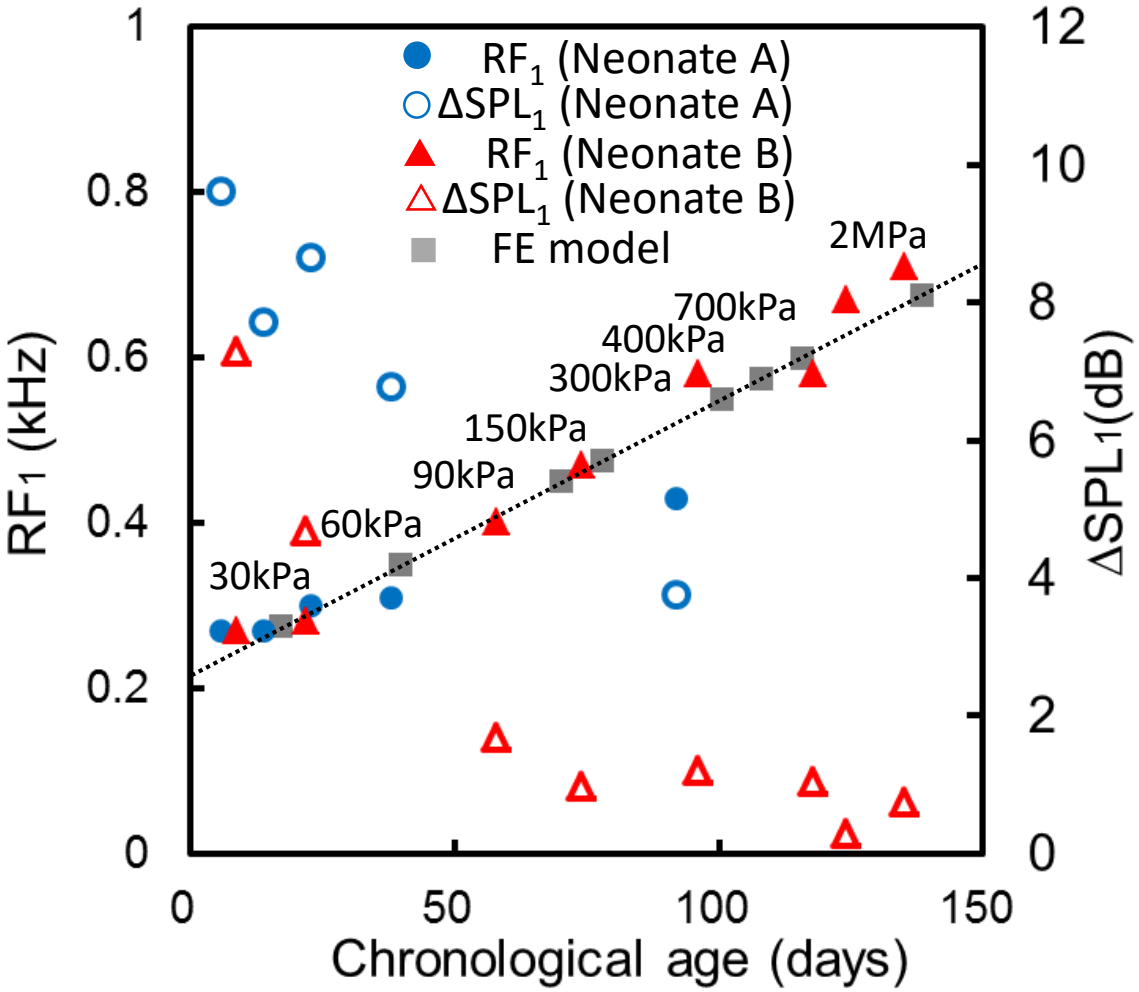
SFI and FE model







SPL curves, obtained from SFI (a) and FE simulations (b). In the FE simulation, the Young's modulus of the soft tissue of the ear canal (Eec) was set from 30 kPa to 2 MPa.



Distribution of the RF_1 and ΔSPL_1 values from SFI measurements in two neonates, and corresponding FE simulations with different ear-canal wall stiffnesses.

Topic 2

子供から年配まで様々な世代で
愛好者が多い剣道が
聴覚に及ぼす意外な影響とは？

(2)コンタクトスポーツにおける骨導の低減

コンタクトスポーツにおける骨導の低減

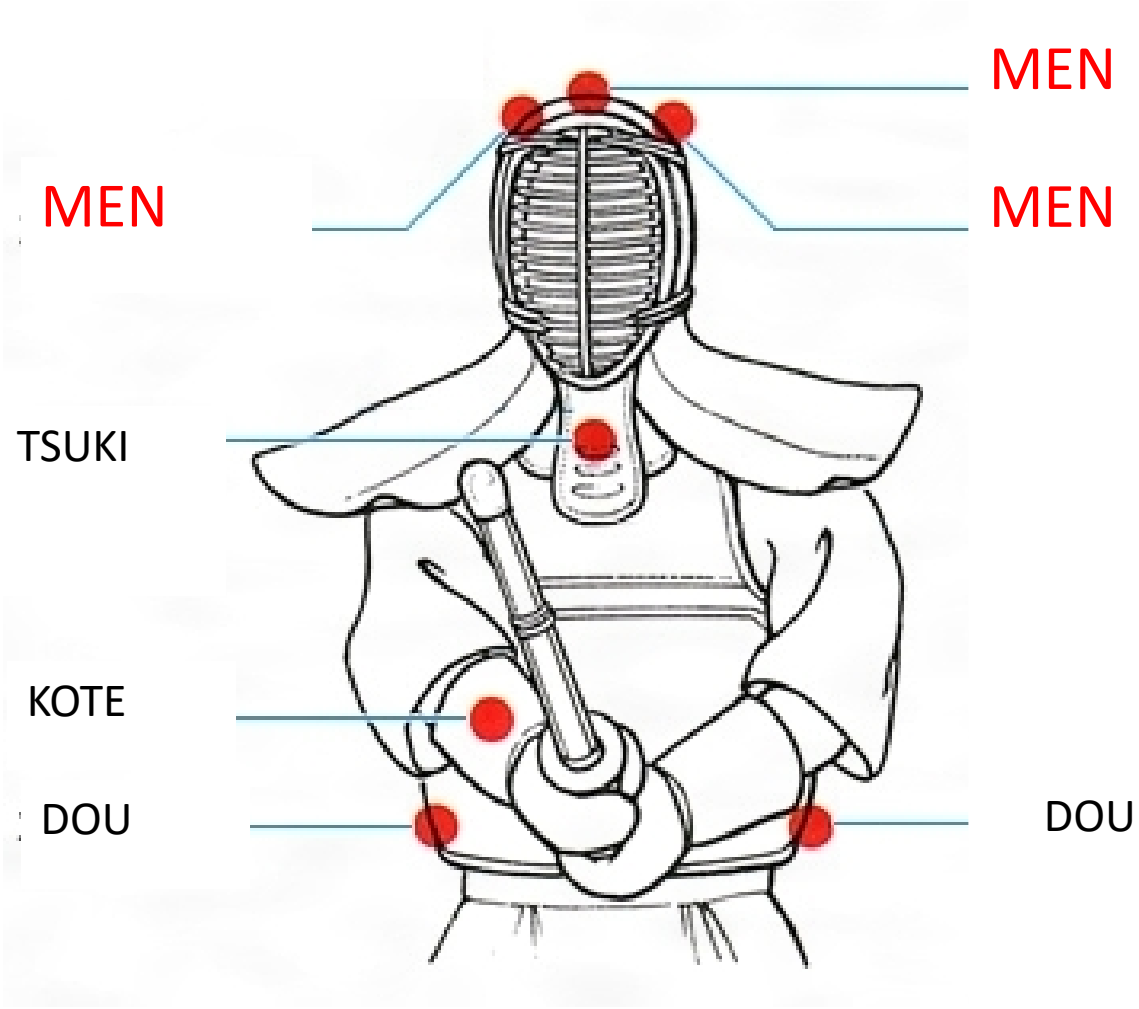
科研費（基盤研究C）17K01775 (3,600千円) *研究代表者

Japan: 1.8 million
Korea
USA　etc…

Instruction at Stanford, USA (2013)

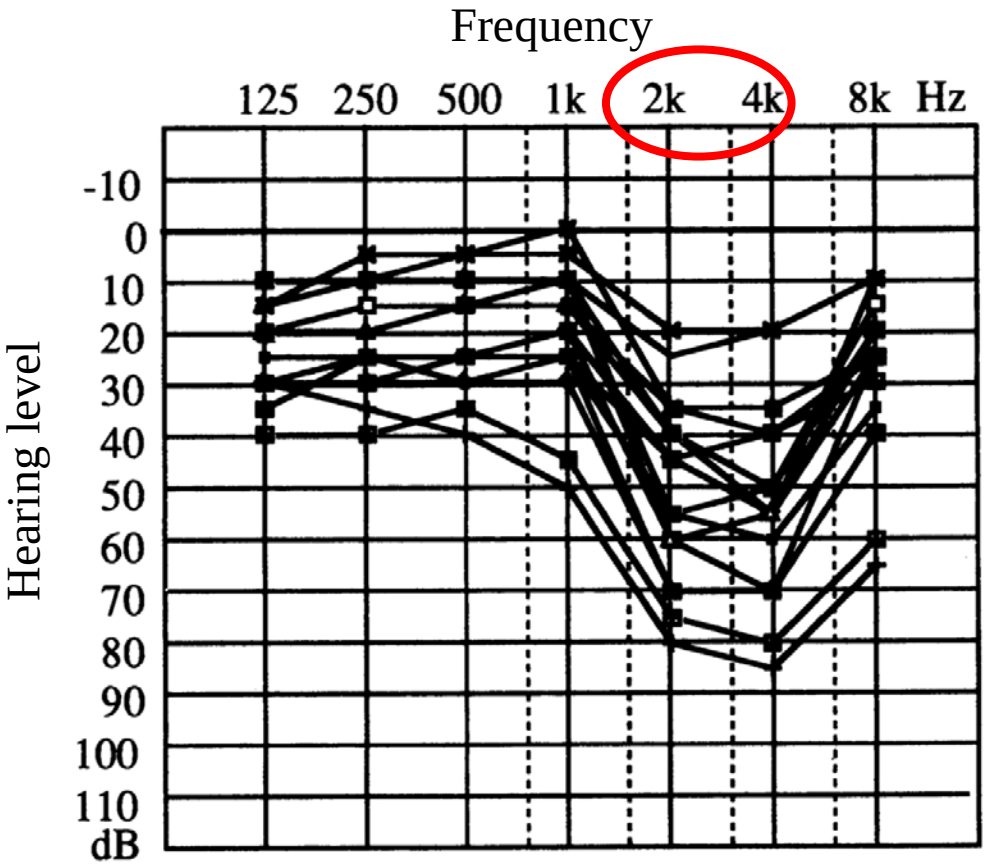
- Modern Japanese sport/martial art
- Descended from swordsmanship
- Bamboo swords (shinai) and protective armor.

Target areas for points



Hearing Loss in Kendo Players

- Hearing loss above 4 kHz (Nakiri, 2009)
- Hearing loss at 2 and 4 kHz (Kato *et al*., 1996, 2012)



Kato *et al*., 1996

Chronic Traumatic Encephalopathy (CTE)

慢性外傷性脳症

- American Football
- Boxing
- Ice hockey
- Wrestling

Science News *from research organizations*

Retired NFL players may be at risk for hearing loss and tinnitus

Date: July 7, 2014

Source: Loyola University Health System

Hearing Impairments

While there is a vast body of literature concerning the results of single head injuries, only a few papers have been published on the effects of repeated

noticeable pathological findings; there existed no difference between groups 1 and 2.

In the adult group of amateur boxers six audio-

Goal of our study

Hypothesis:

Accumulation of small concussions in the inner ear by the impact of the bamboo sword on the head

Physiological approaches :

- Audiometry
- DPOAE
- ABR
- Bone conduction mapping

Computational approaches :

- FE model of a human head
- FE model of a kendo helmet

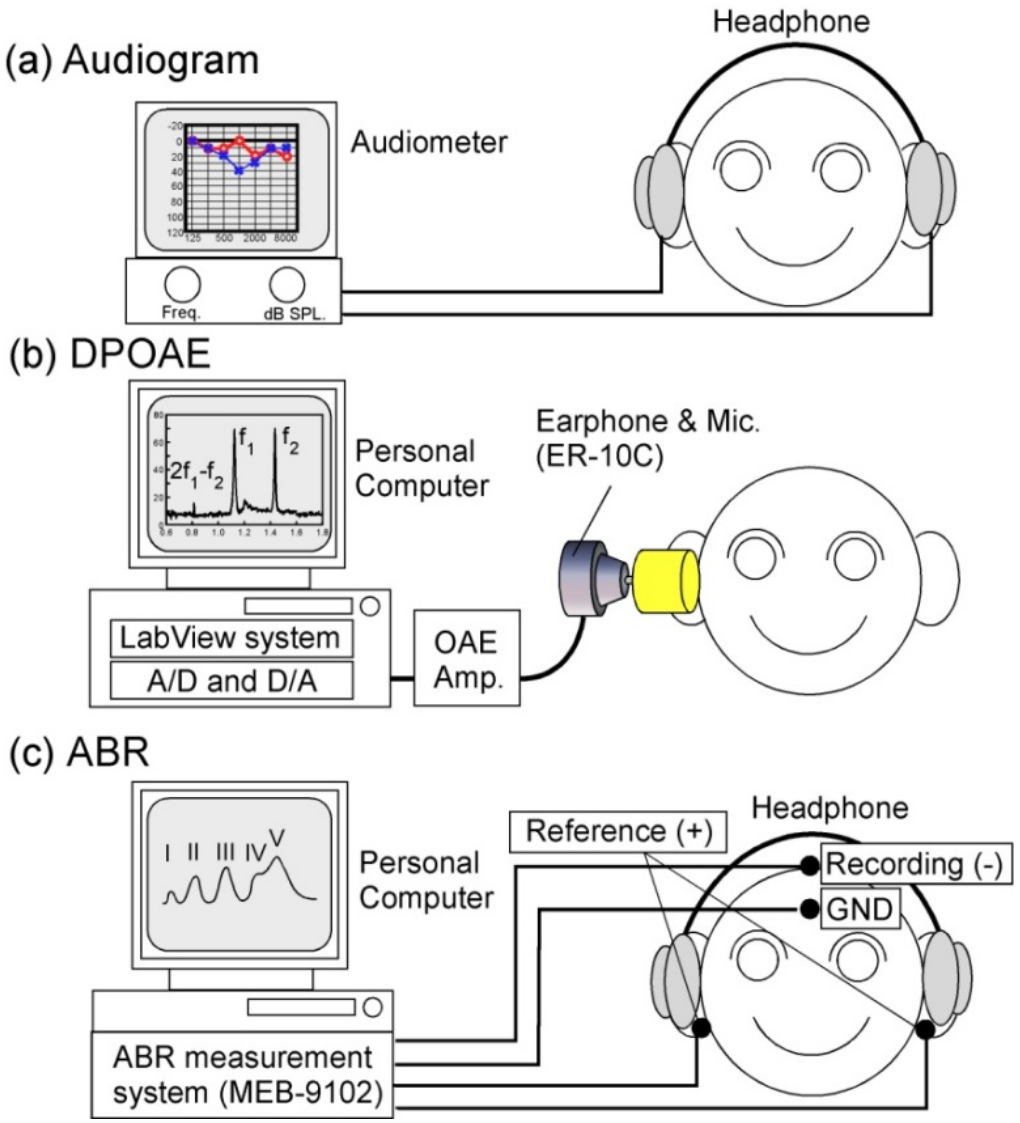
Physiological approaches

仙台高専剣道部

3rd Place in 52th National Kendo Championship for Students in National College of Technology (Aug 20, 2017)

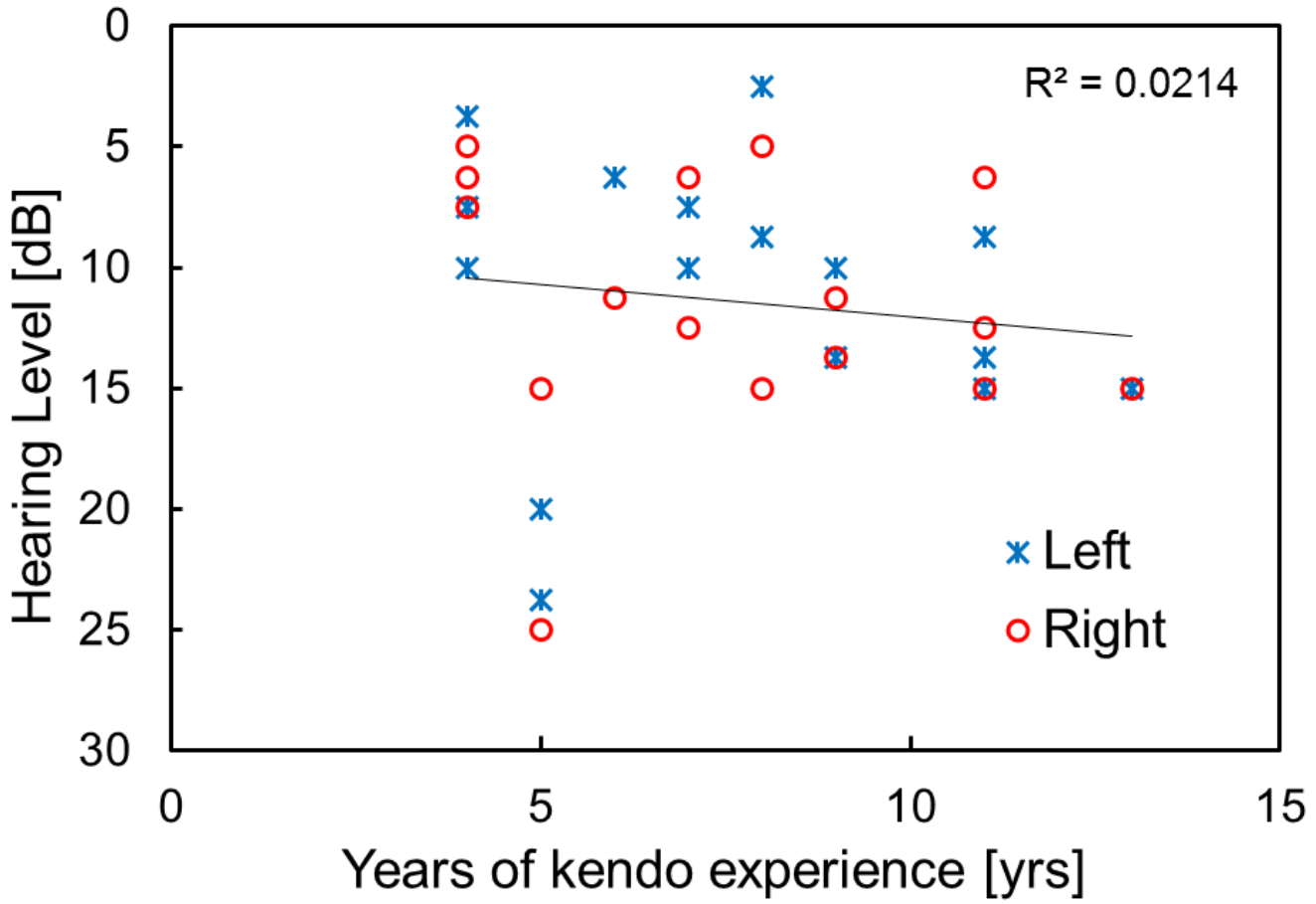
Physiological measurements in kendo players

- Kendo team
  Sendai National College of Technology
- 16 subjects aged 15 to 18 years
- The length of their kendo experience ranged from 4 to 13 years
- 1.5 hours of kendo training



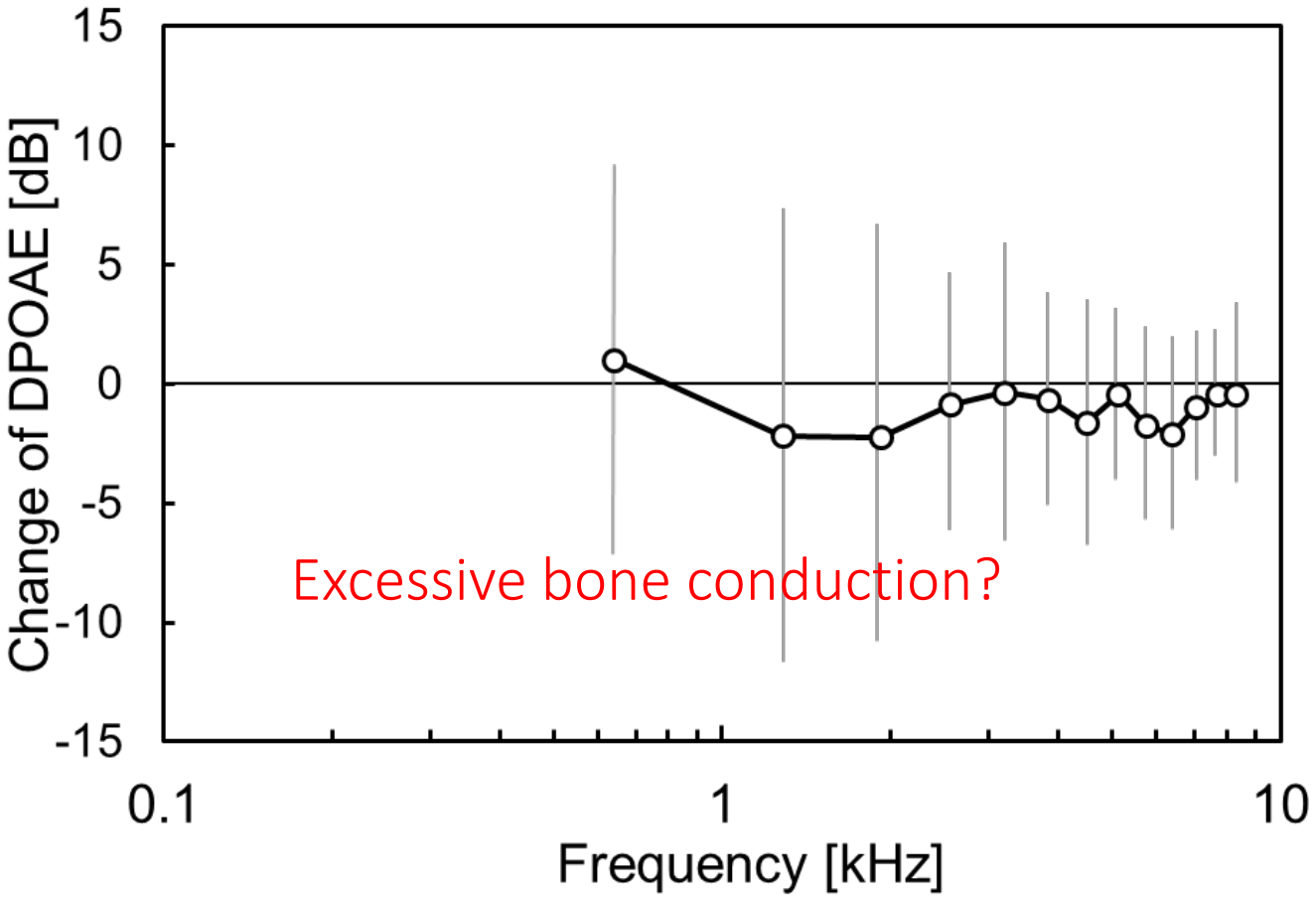
Audiogram

Age: 15 to 18 years



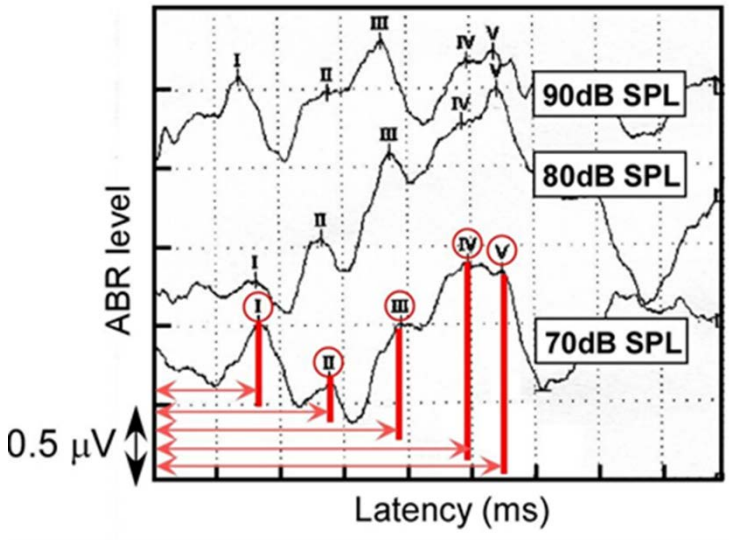
Relationship between years of kendo experience and hearing level measured by audiometry. The thin solid line is linear approximation (n=16).

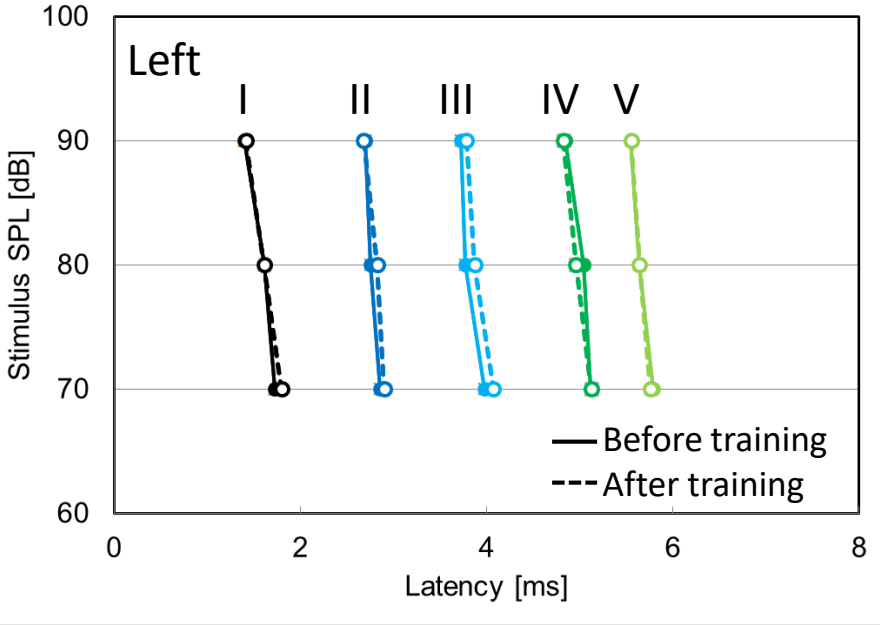
DPOAE

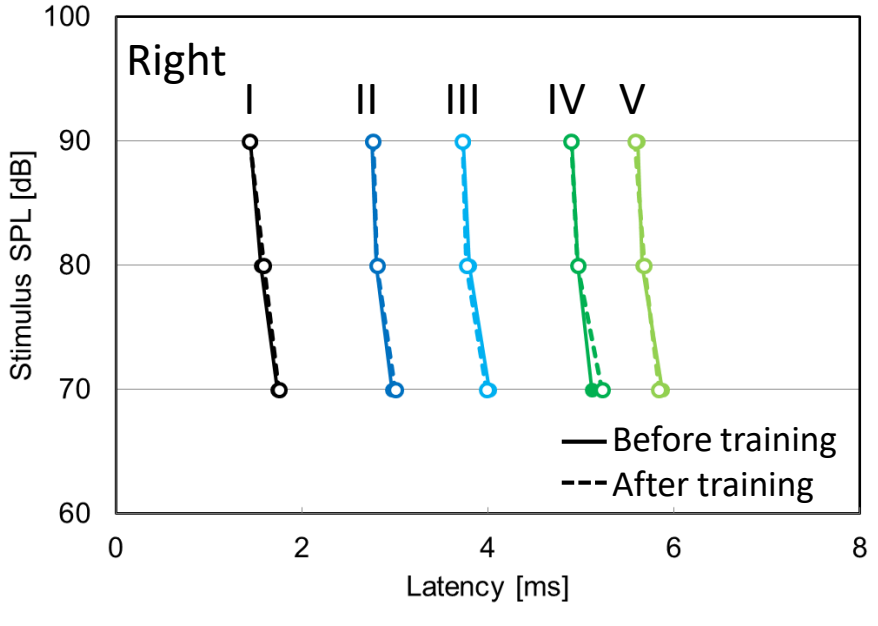


Change of DPOAE levels between before and after 1.5 hours of kendo training (n=16). A negative value means a decrease in level and the thin solid line is standard deviation.

ABR



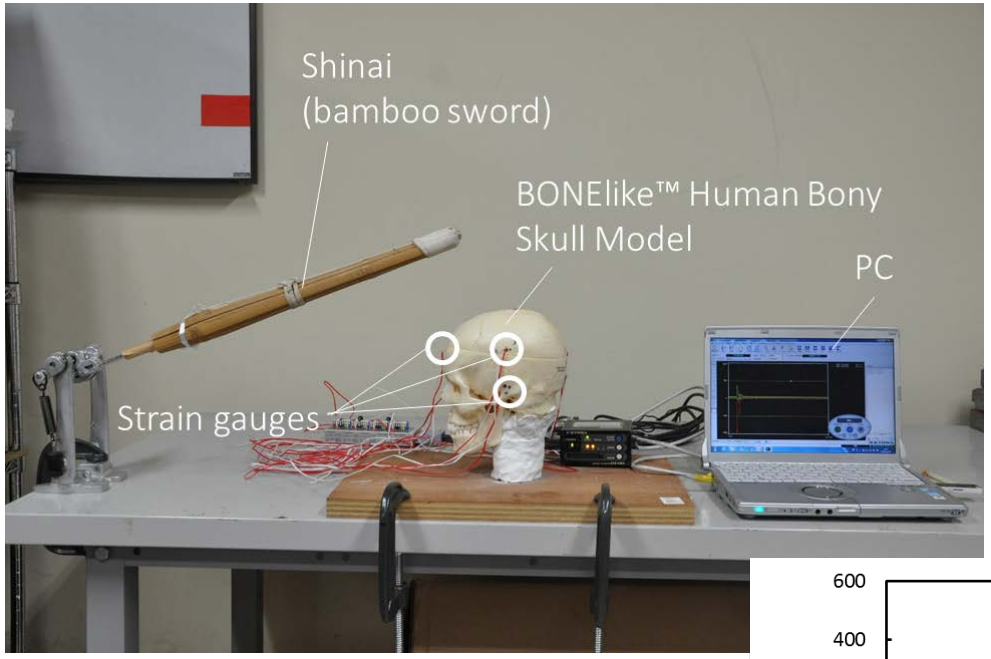


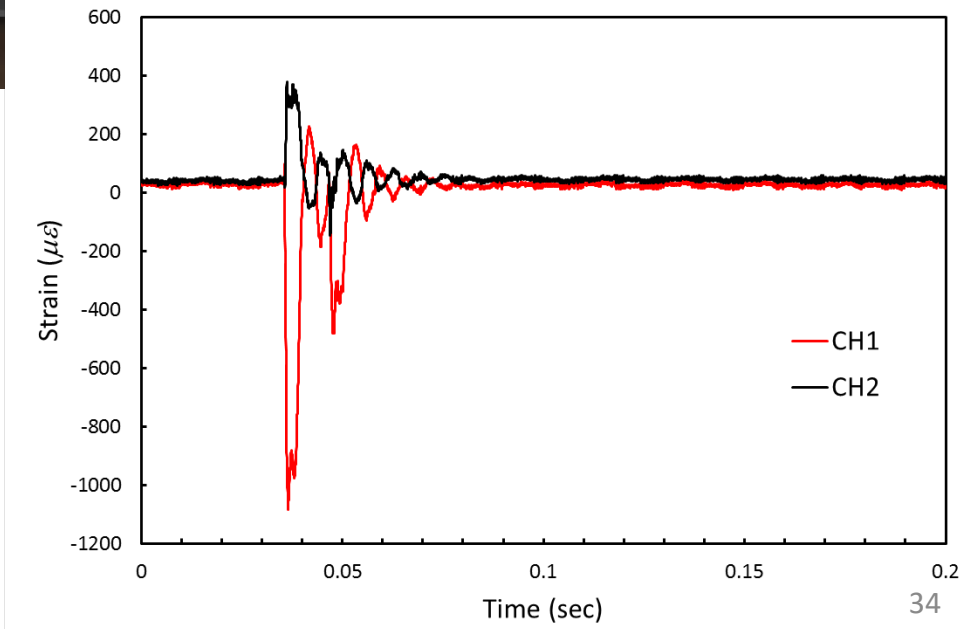


Effects of kendo training on ABR latency (n=16).

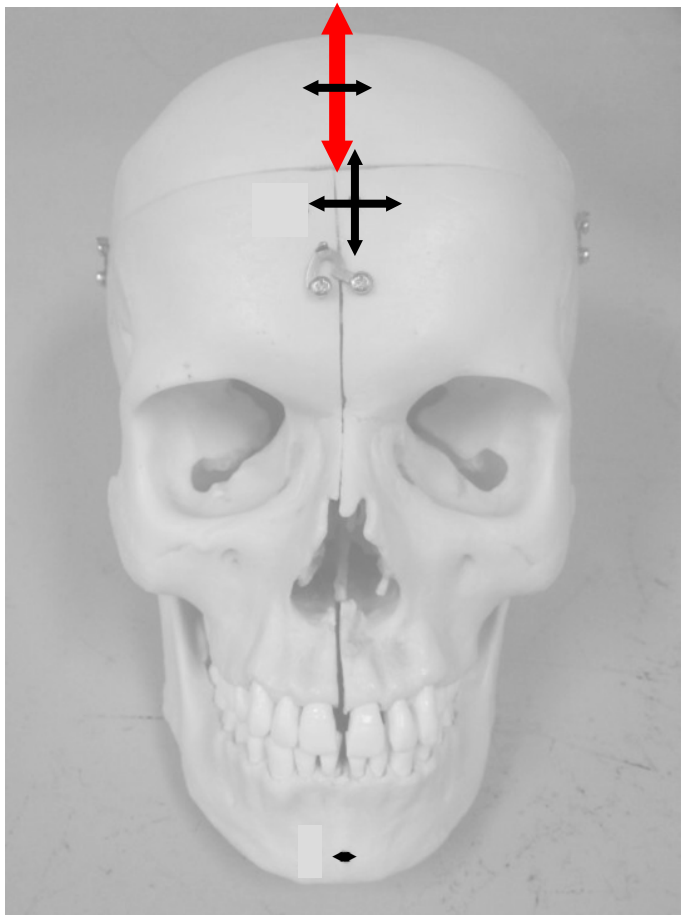
Bone conduction mapping

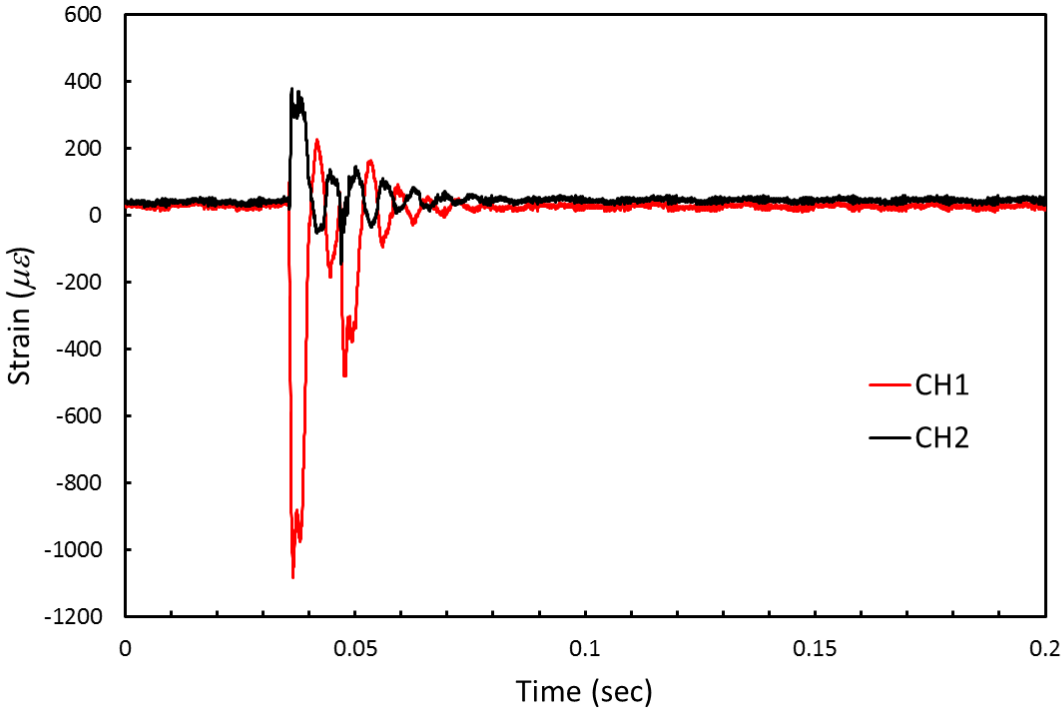
Bone conduction mapping



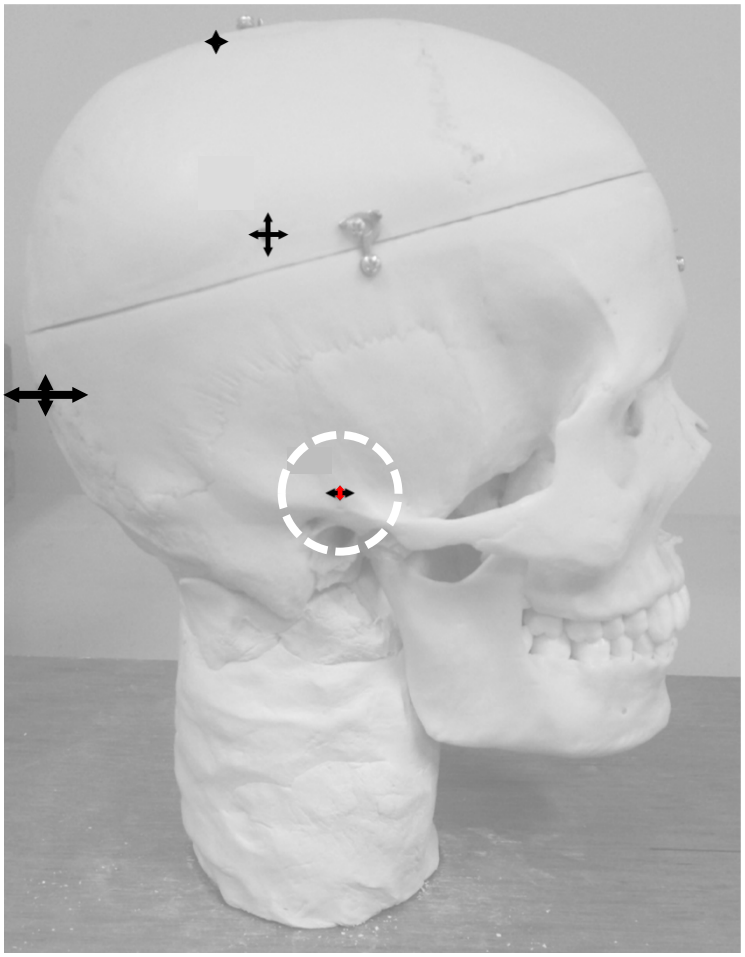


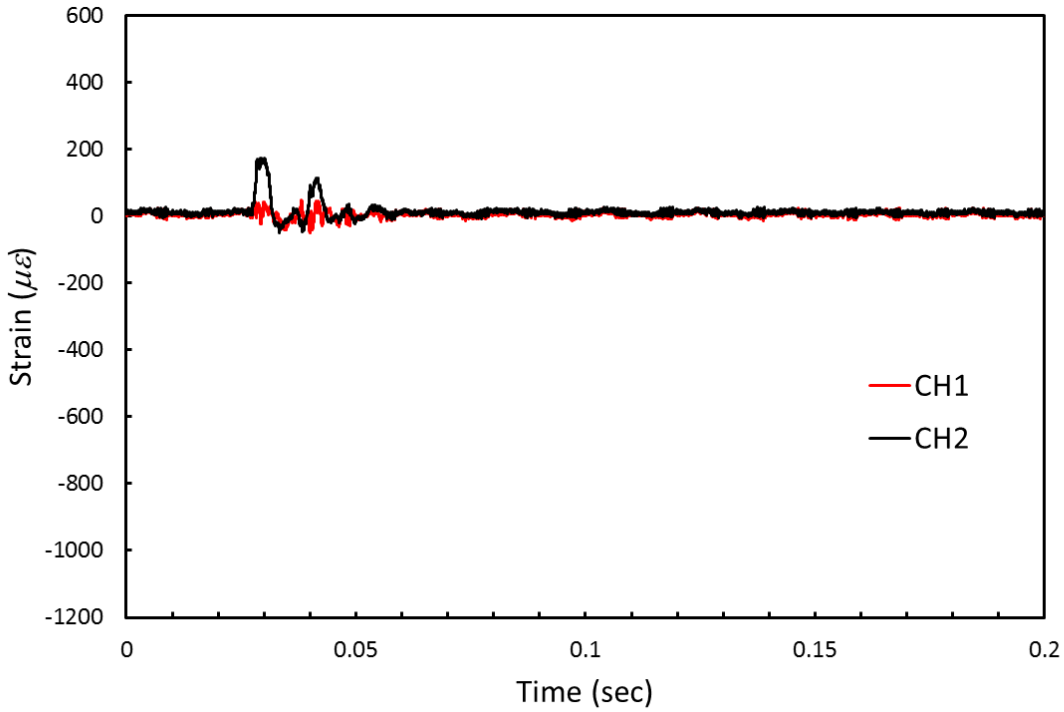
Bone conduction mapping (Impact area)





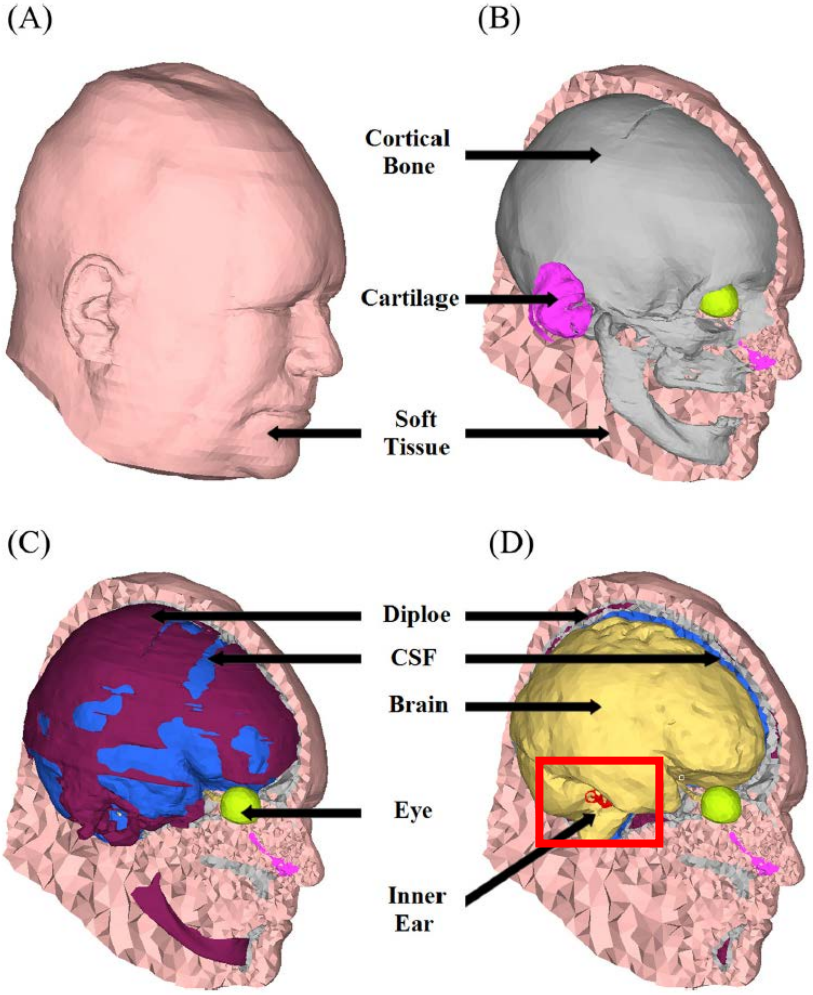
Bone conduction mapping



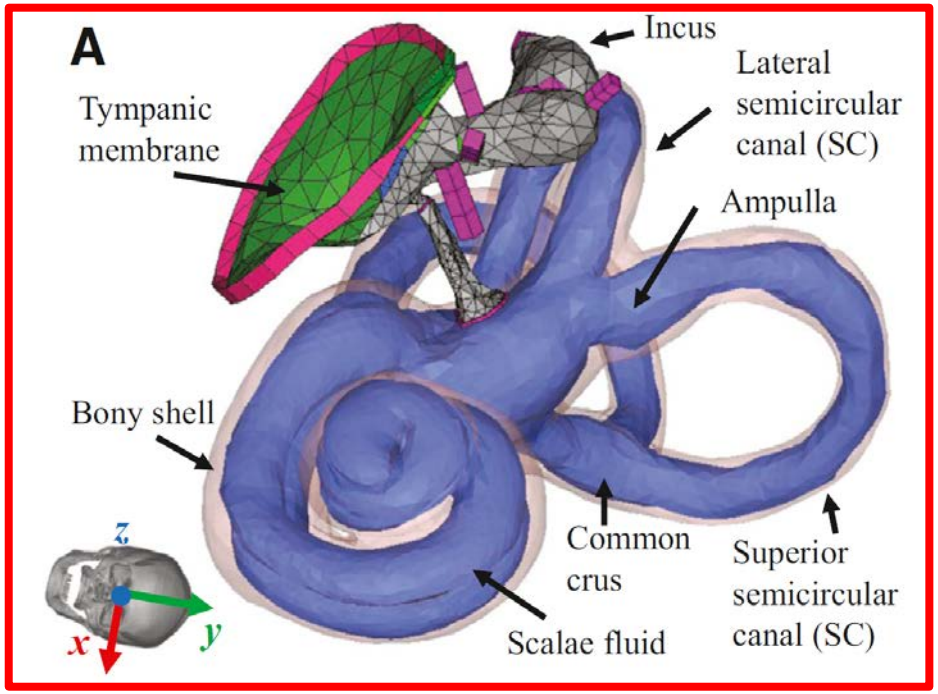


Computational Approaches

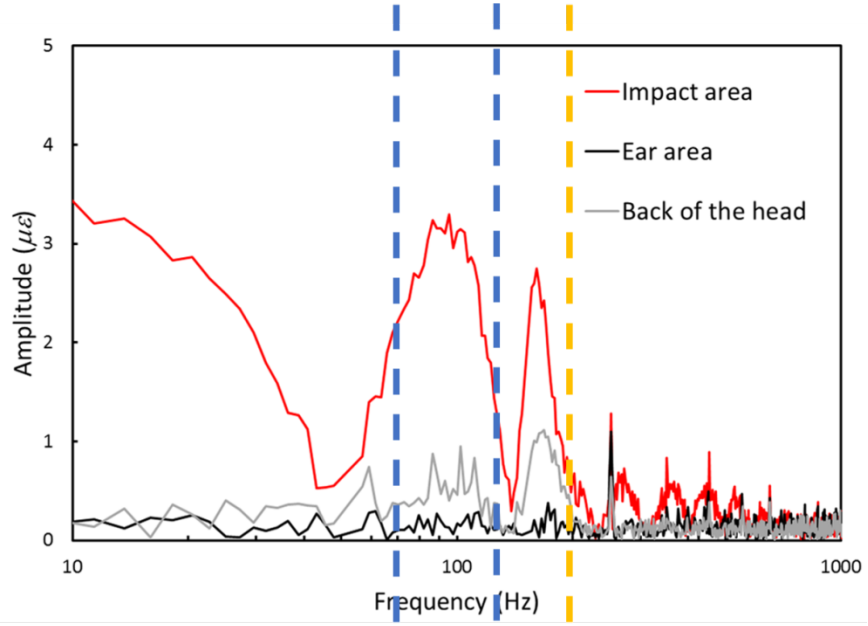
FE computational model of a human head

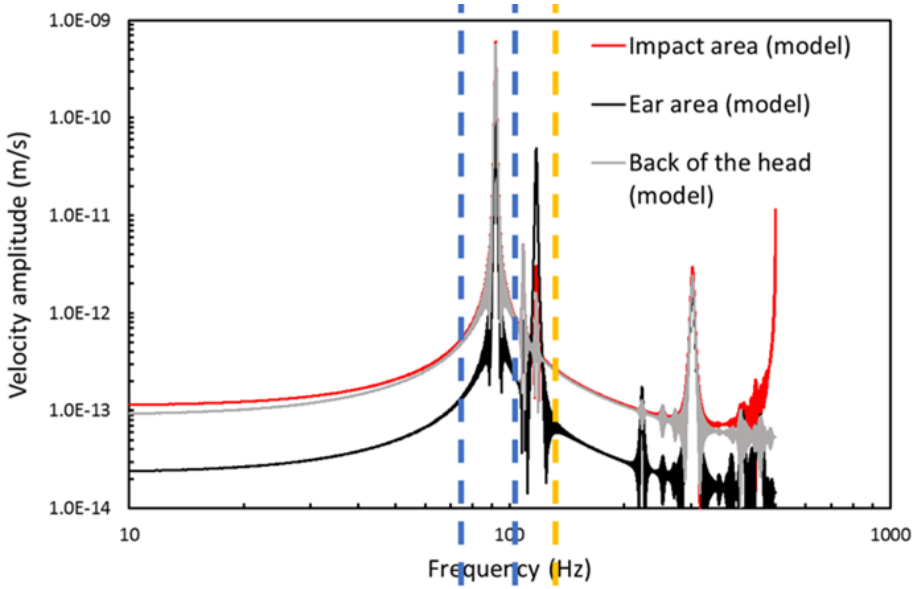


- Skull, brain, soft tissue, and cartilage
- Auditory peripheries, including the middle ear, cochlea and semicircular canals

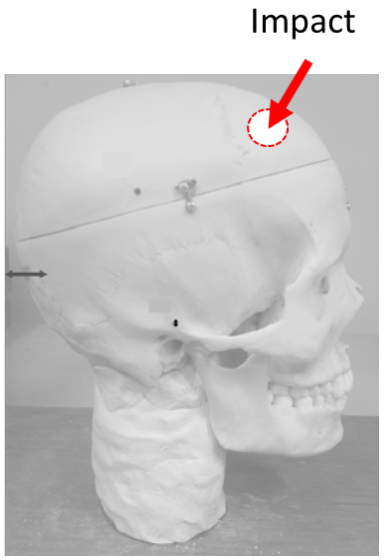


N. Kim *et al.*, JASA (2016)

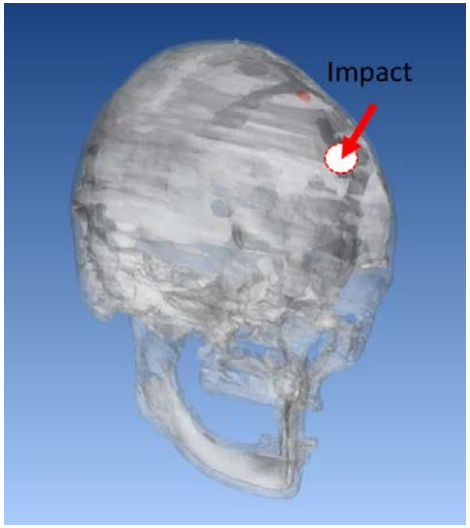




BONELike™ skull model

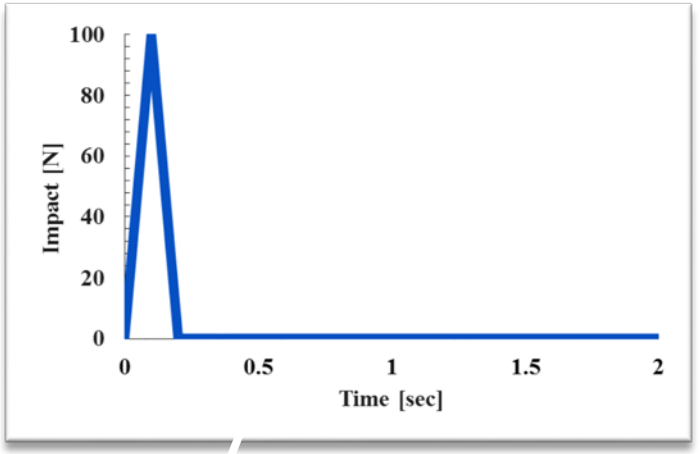


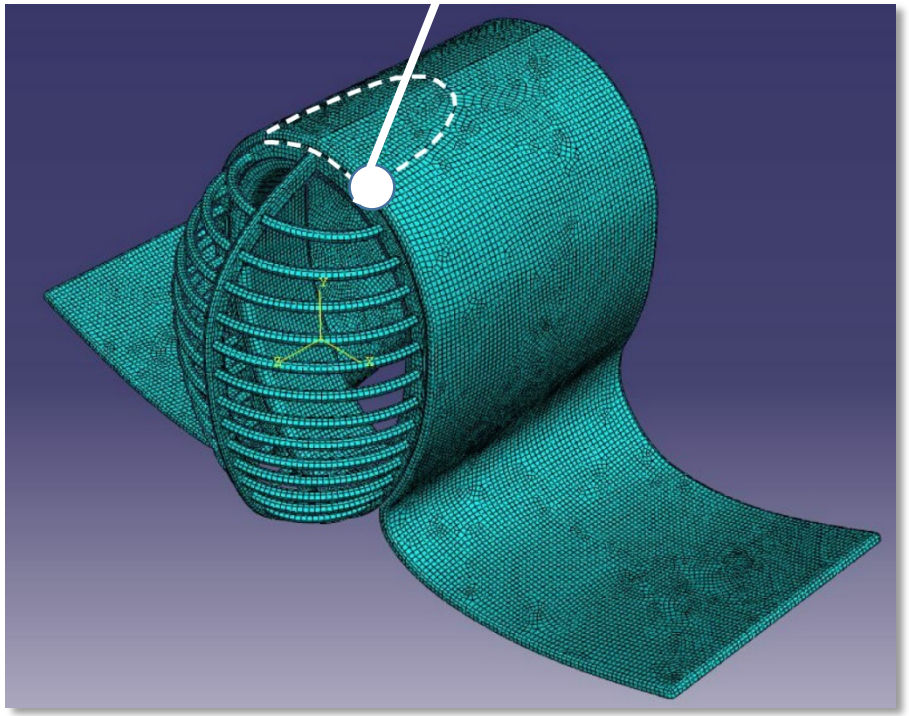
Computational skull model



FE computational model of a kendo helmet

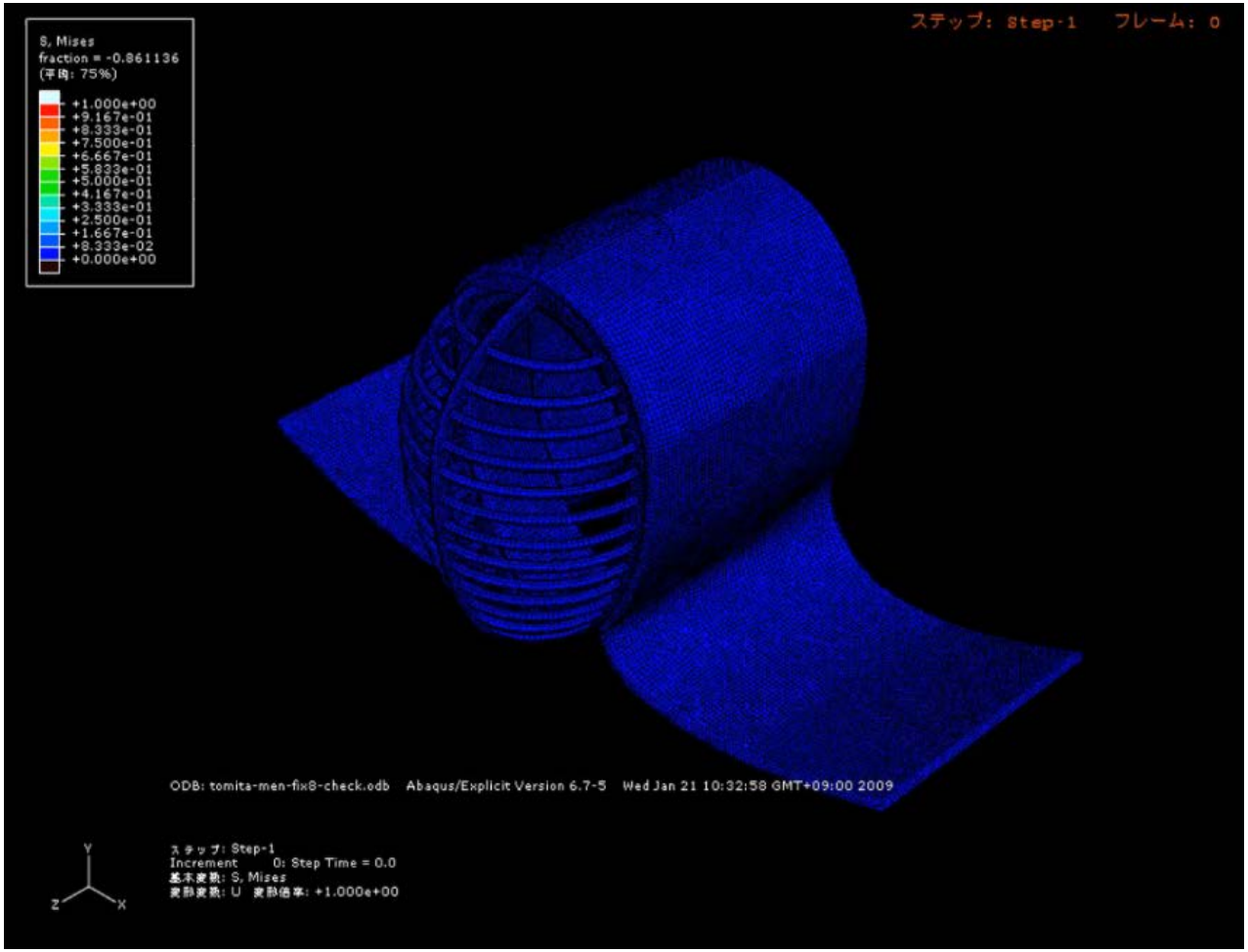
- Shell element
- Total elements: 73382
- Thick cloth for head protection
- Titanium alloy for facial protection
- ABAQUS





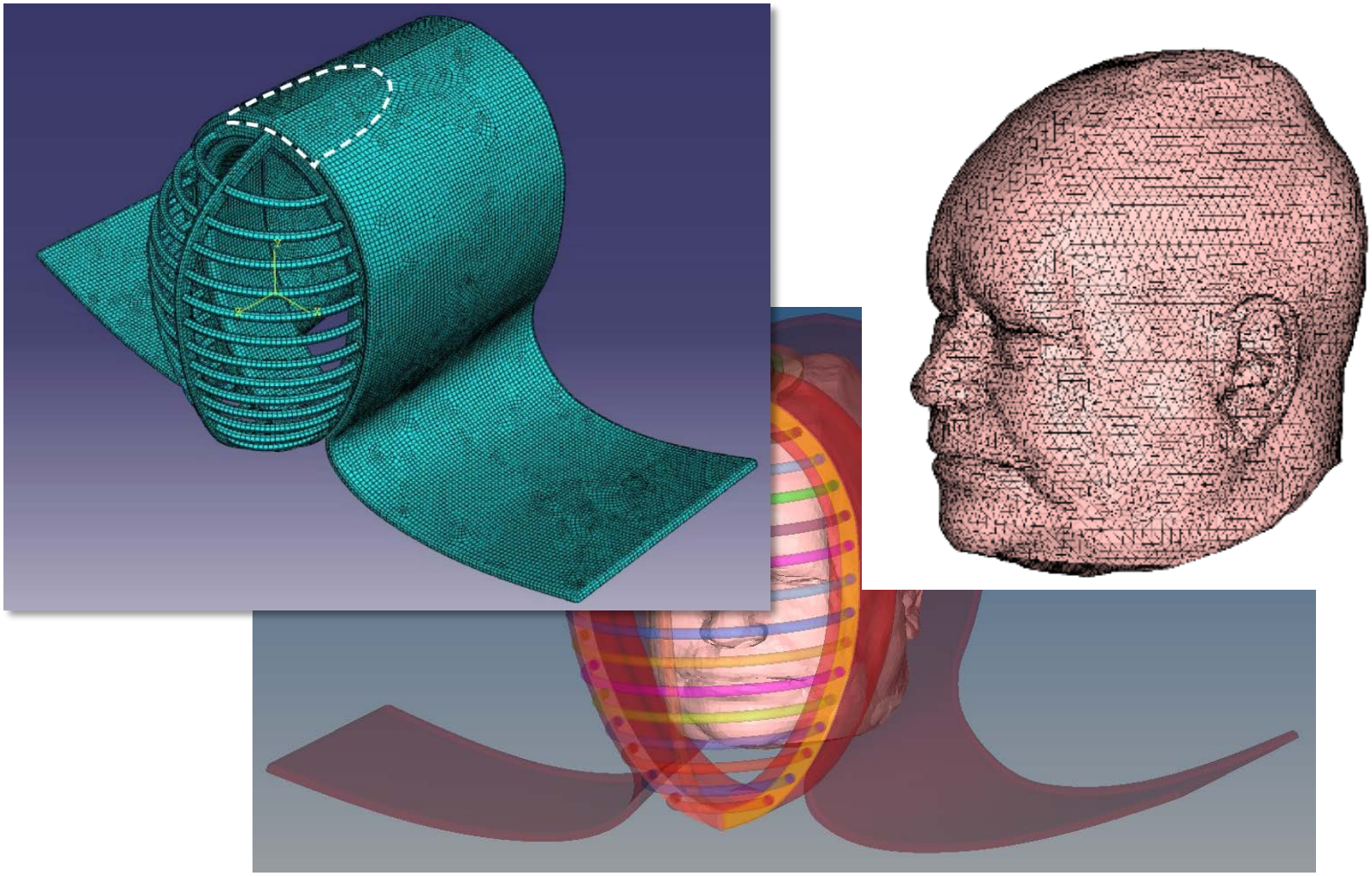
Hamanishi and Aoki, 2010

FE computational model of a kendo helmet



Future work:
Coupled model of human head and MEN

Hamanishi *et al*., 2010

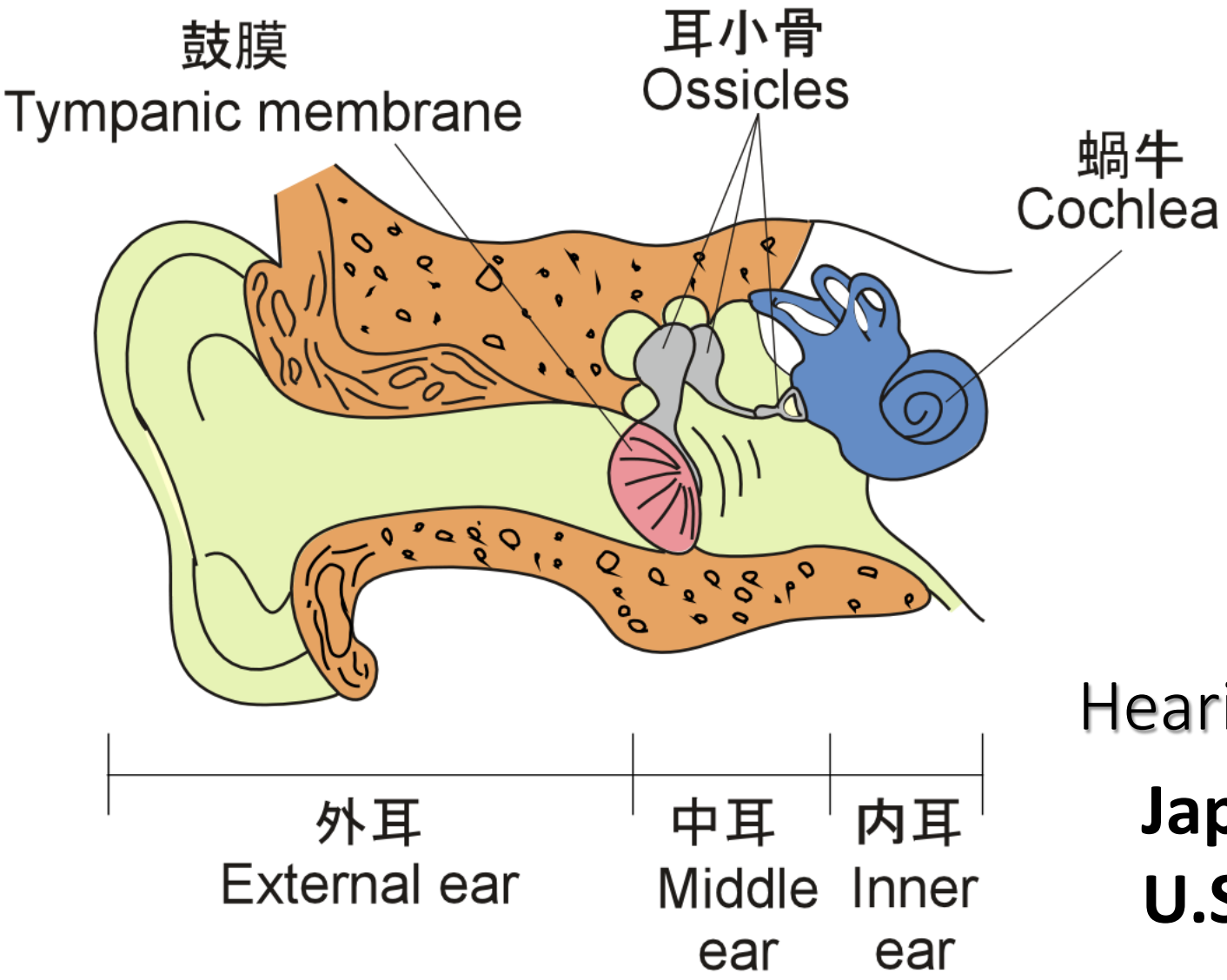


Topic 3

良好なコミュニケーションを提供してくれる新しい補聴器とは？

(3)イヤホンを必要としない補聴器の開発

Human Auditory System

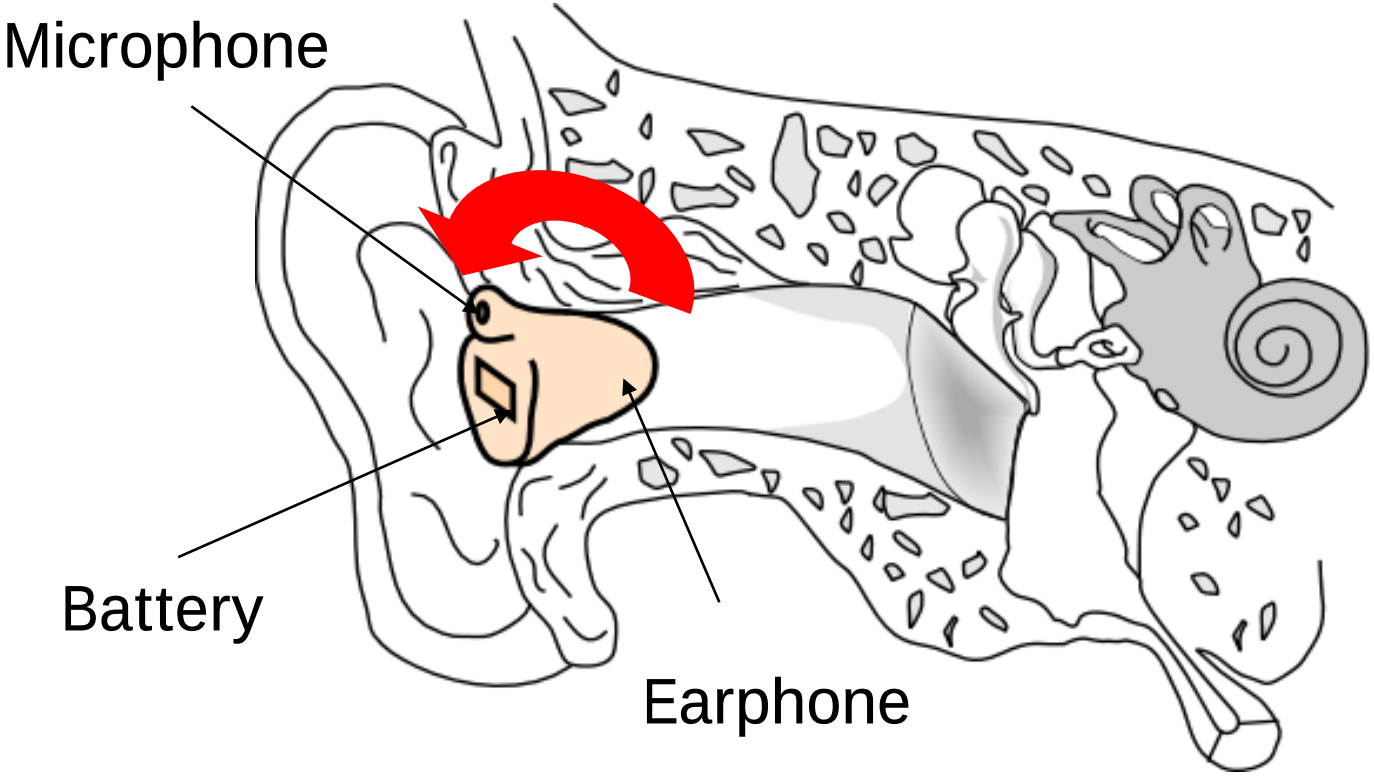


Hearing Loss

Japan: 5 %

U.S.A: 9 %

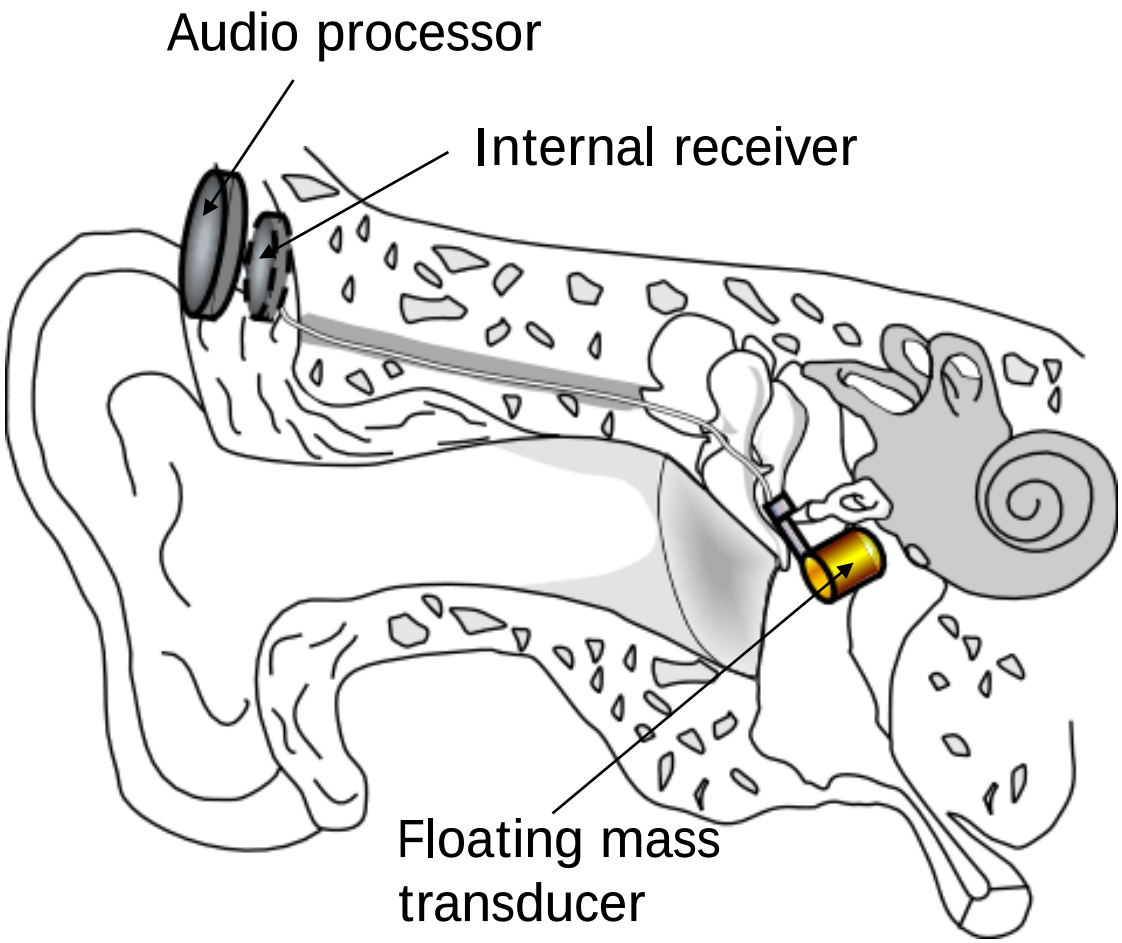
Conventional Hearing Aid

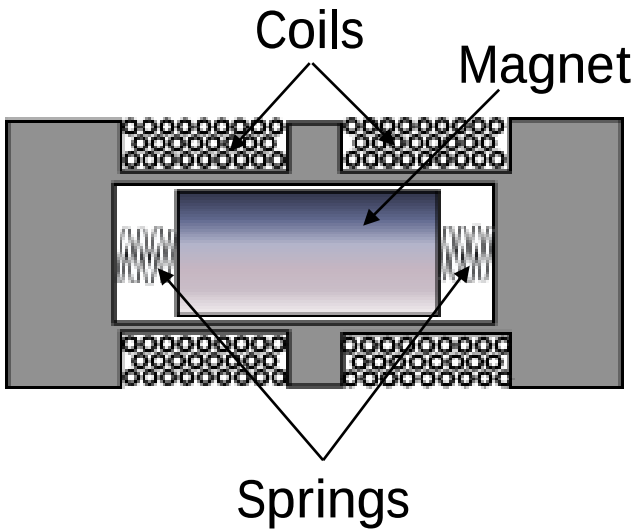


Low gain at high frequencies

Occlusion

Implantable Hearing Aid

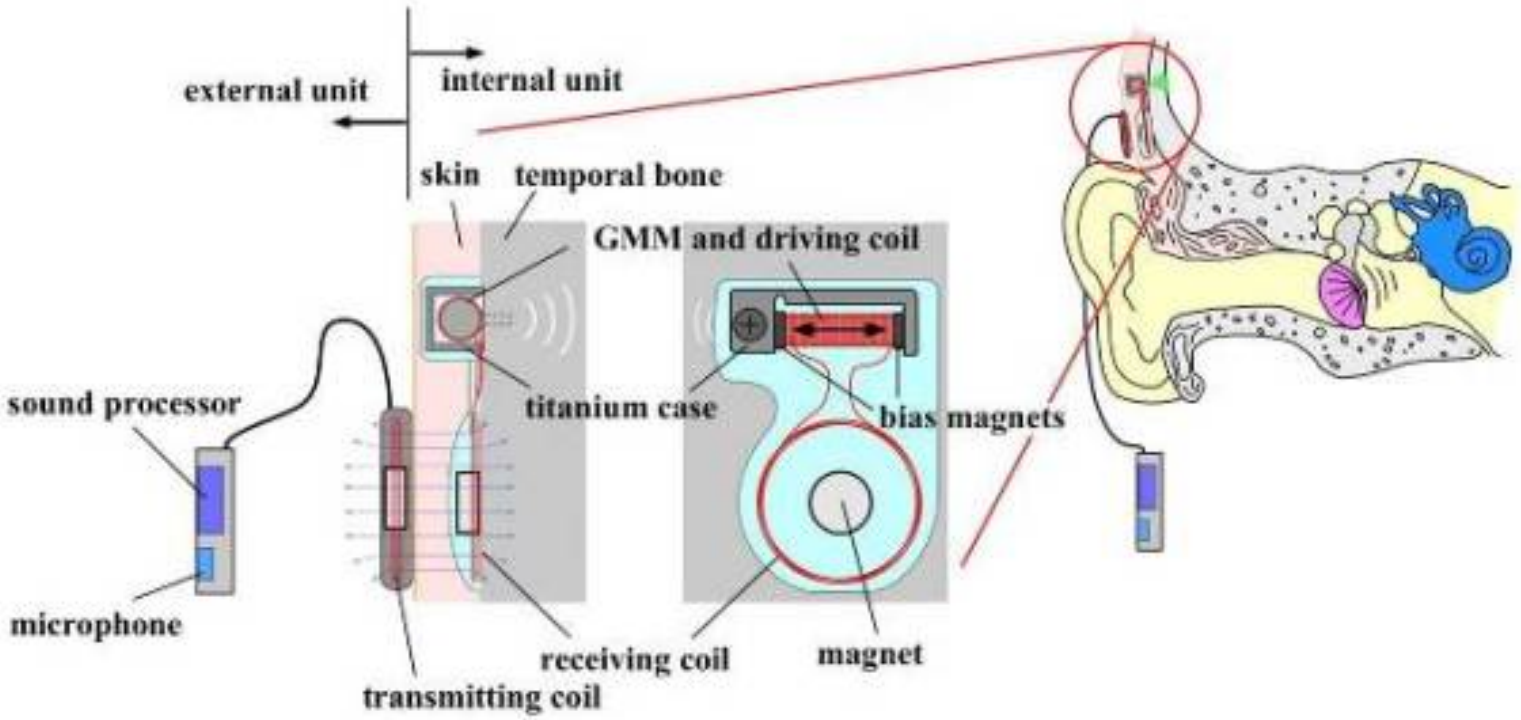




Vibrant Soundbridge®

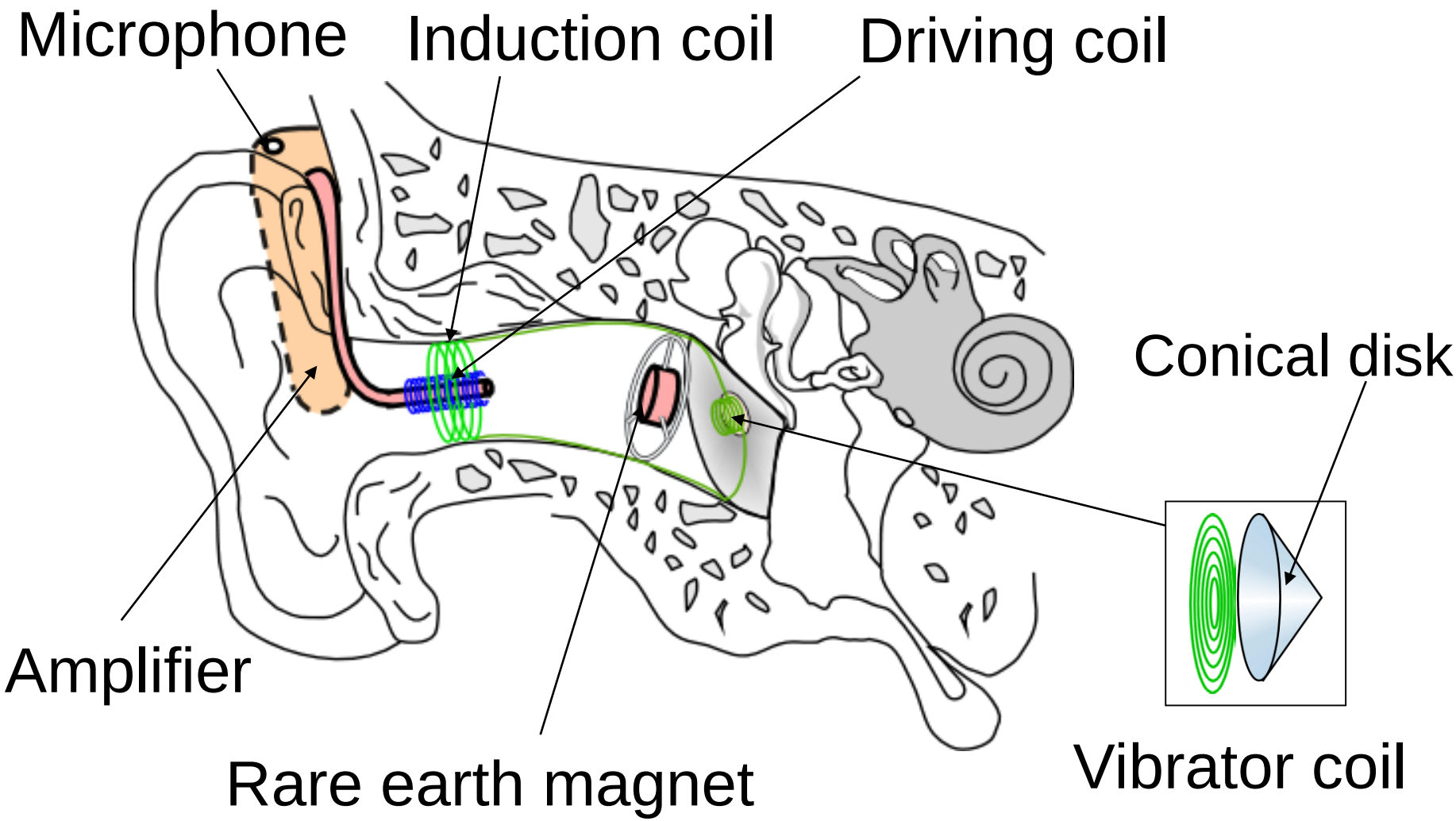
Implantable Hearing Aid

超磁歪素子　(電通大・小池卓二研究室)



小池研究室
http://www.bio.mce.uec.ac.jp/research/experiment.html

Non-implantable Electromagnetic Hearing Aid

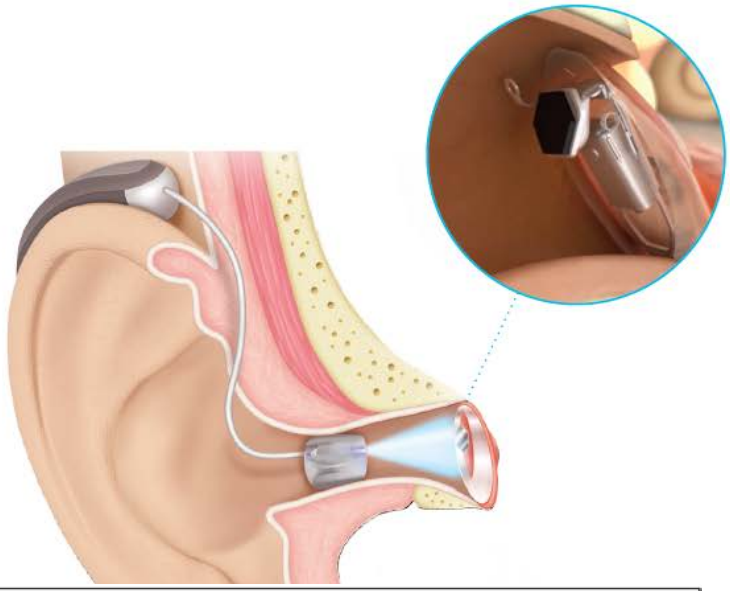


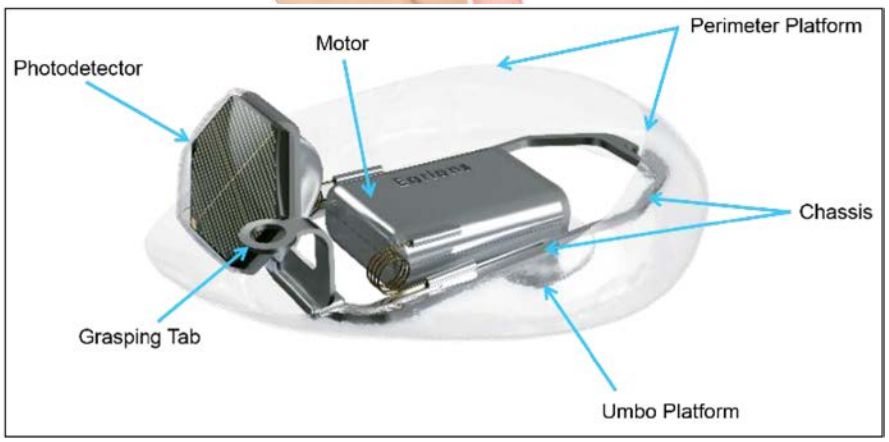
earlens

earlens

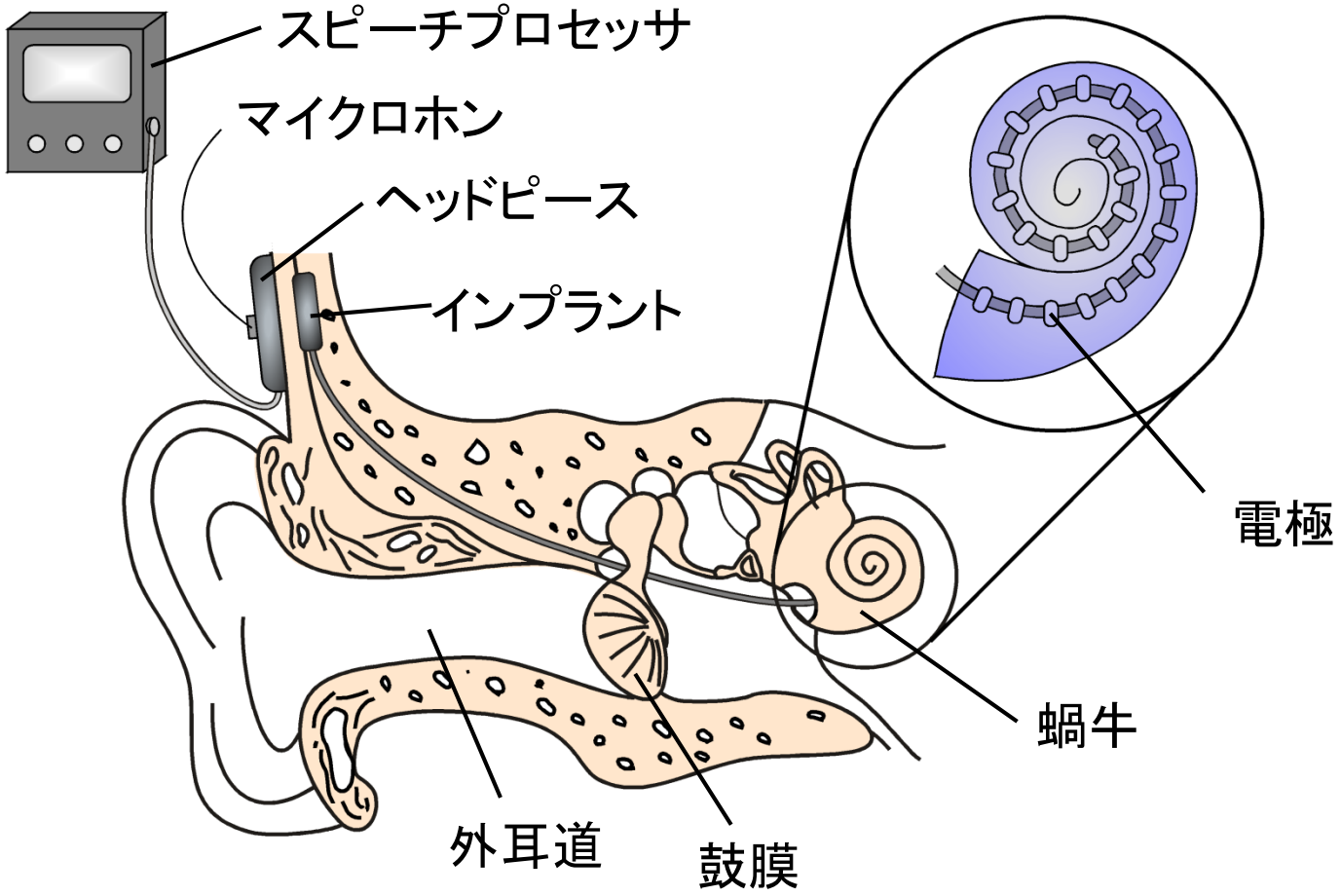
Earlens Light-Driven Hearing Aid

- Most complete sound of any hearing aid
- Automatically adjusts to challenging listening enviornments
- Clinically proven to improve speech understanding*
- Easy, wireless recharging





Cochlear Implant



Cochlear Implant

Contact

濱西 伸治

仙台高等専門学校
機械システム工学科
hamanishi@sendai-nct.ac.jp