

Hørsel og tinnitus

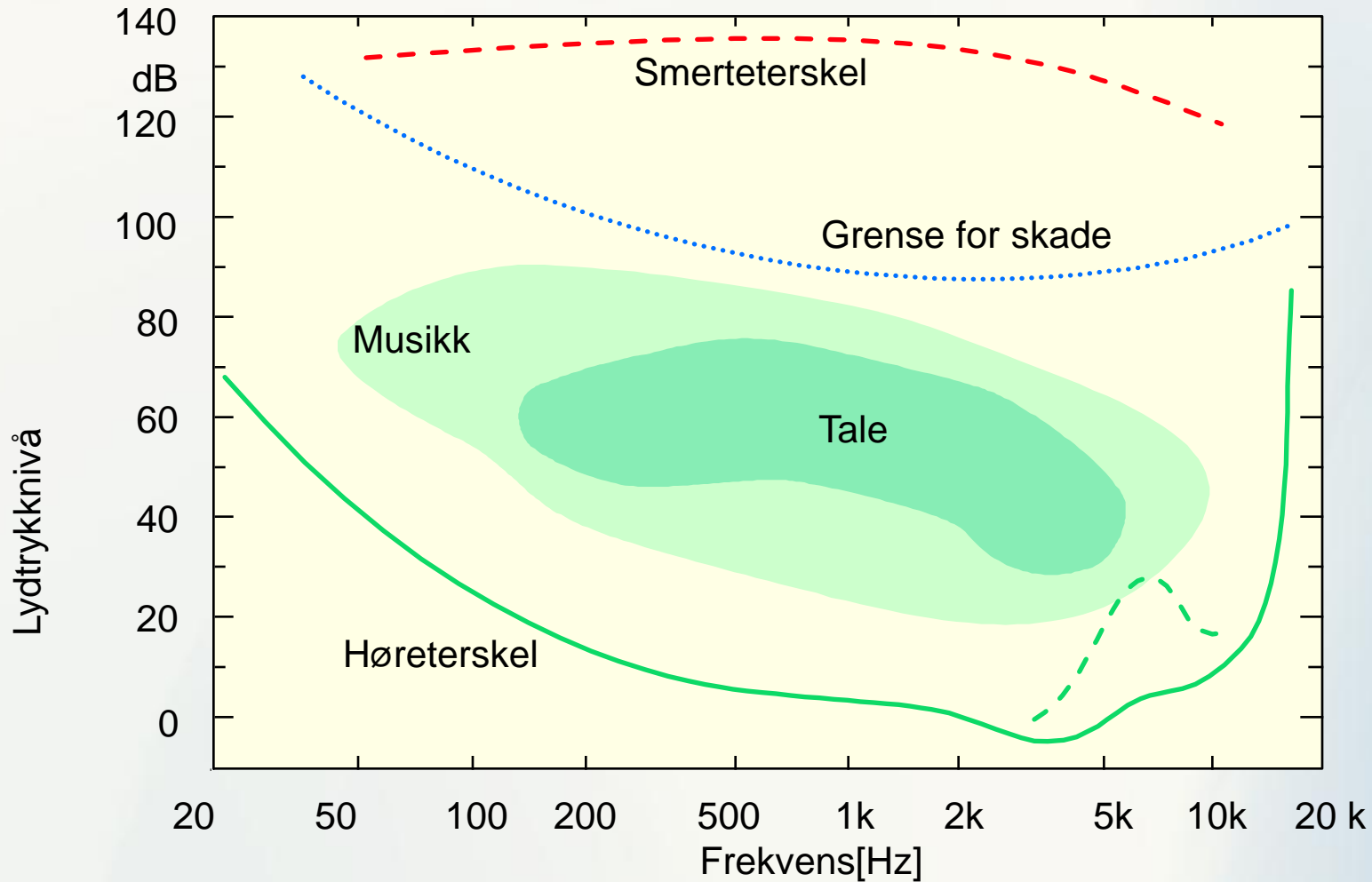


Stavanger 03.05.2012

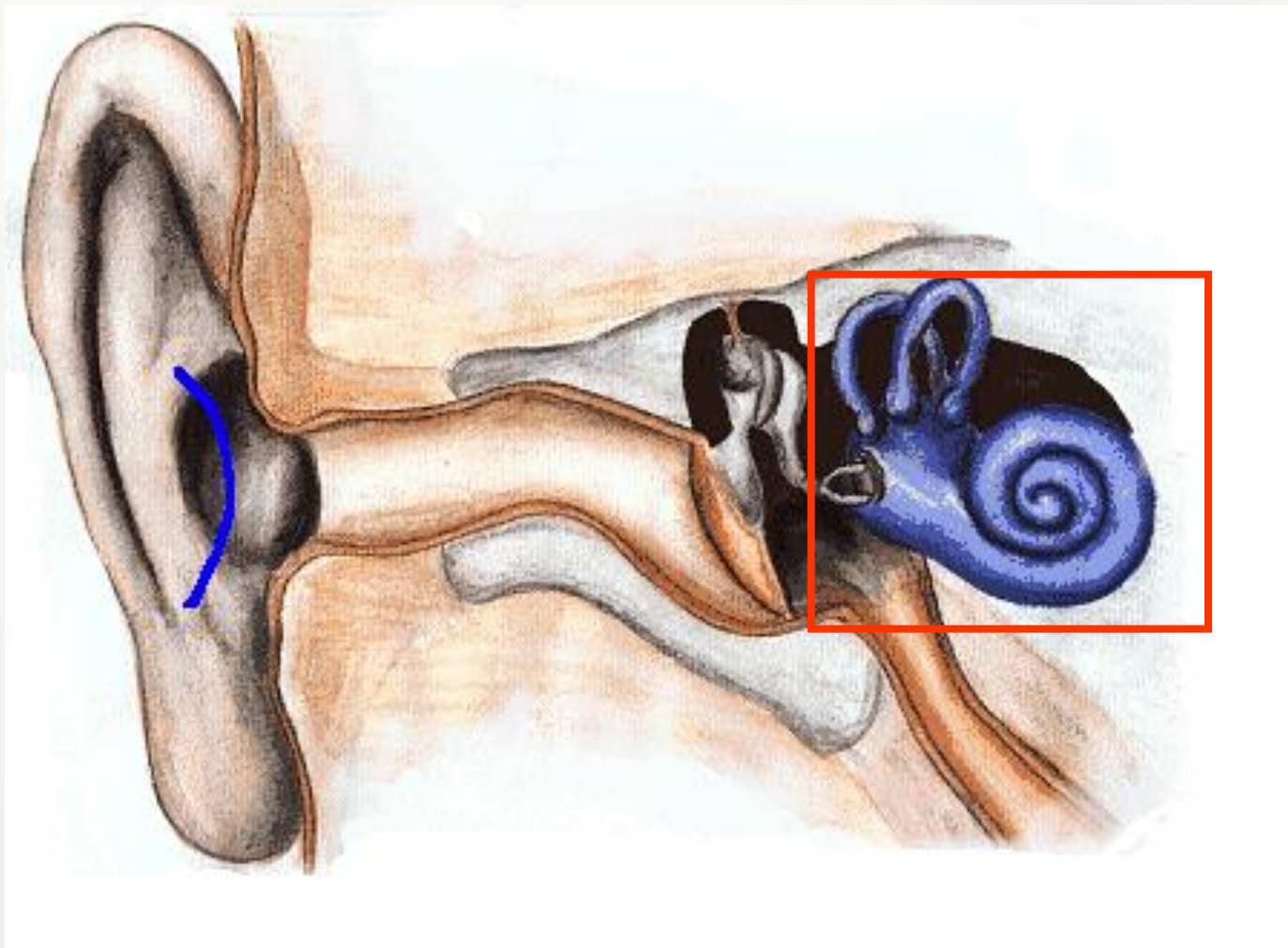
Aage Møller i introduksjonen til siste utgave av "Hearing"

- "It is now recognized that disorders of one part of the auditory system often affect the function of other parts of the auditory system. This is especially apparent with regard to hyperactive disorders such as tinnitus and hyperacusis...."

Høreområde

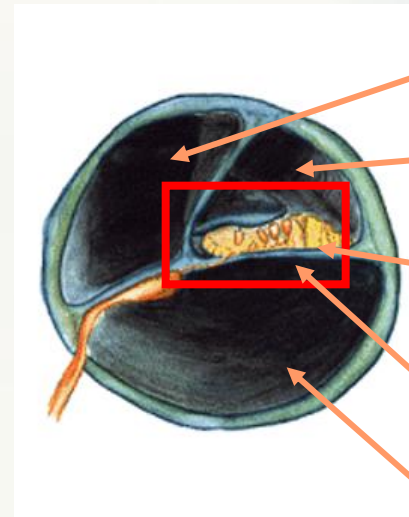
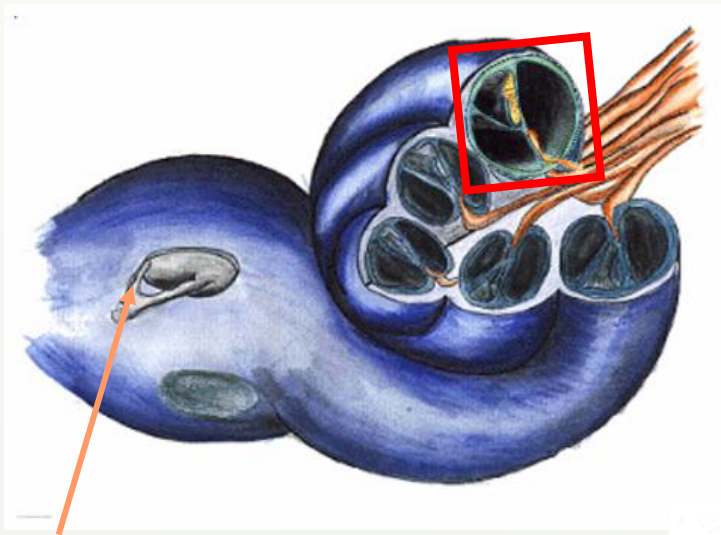


Øret



Det indre øre

Sneglen (Cochlea)



- scala vestibuli
- scala media
- Cortiske organ
- Basilar membran**
- scala tympani

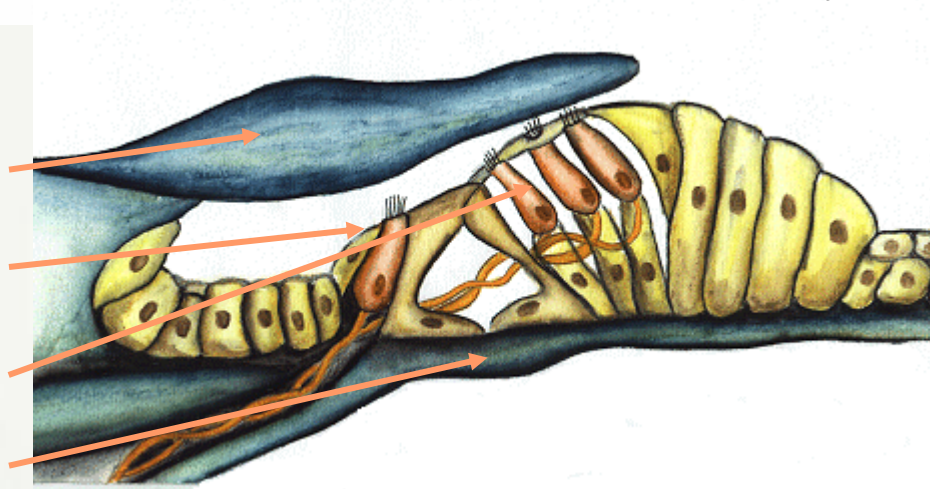
stigbøyle

Tectorial membran

Indre hårcelle

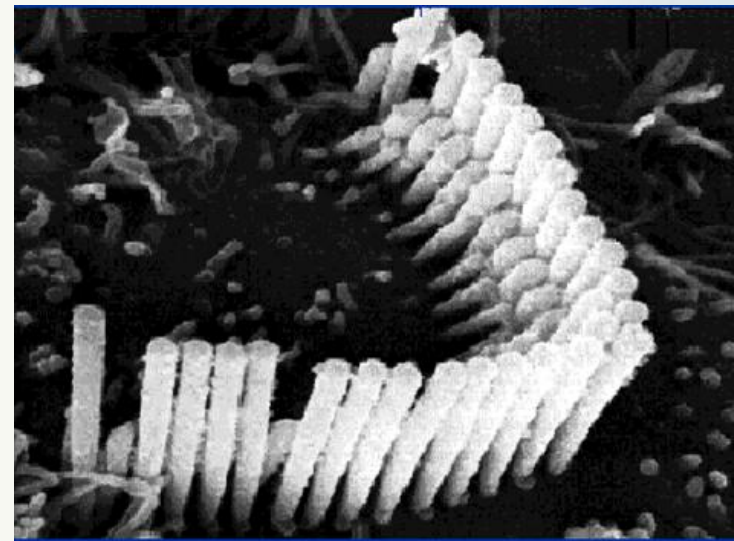
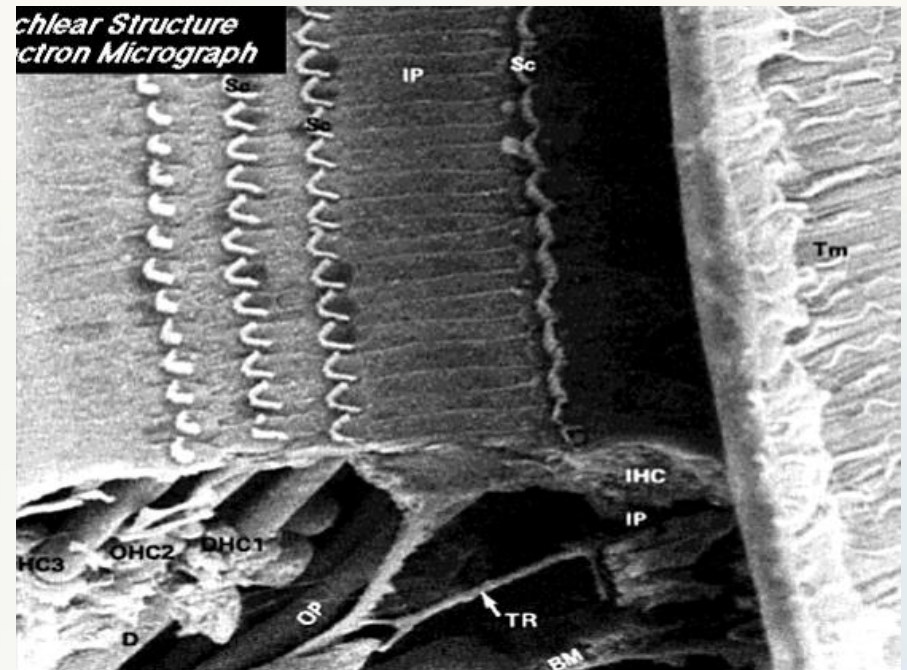
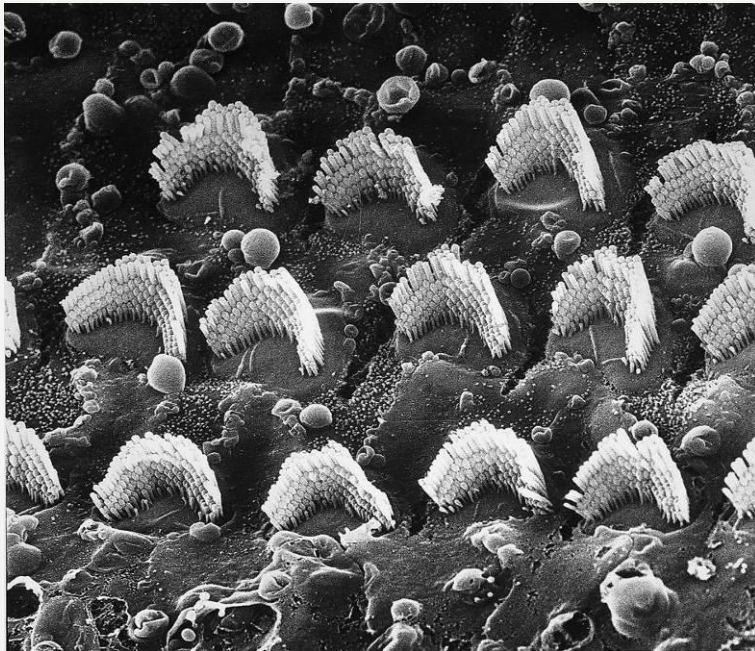
Ytre hårceller

Basilar membran

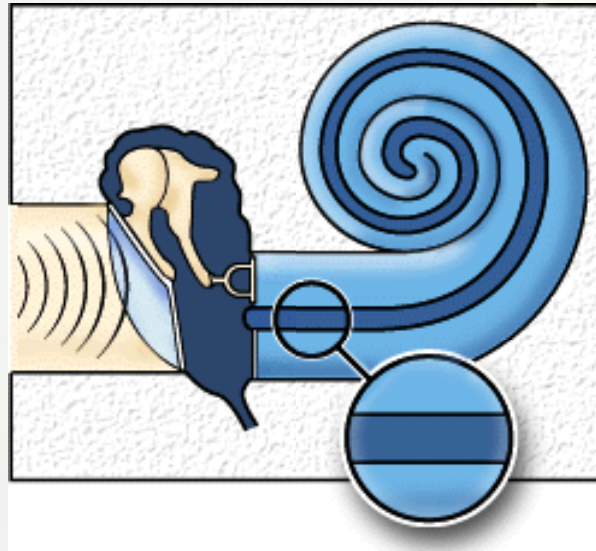


Indre og ytre hårceller

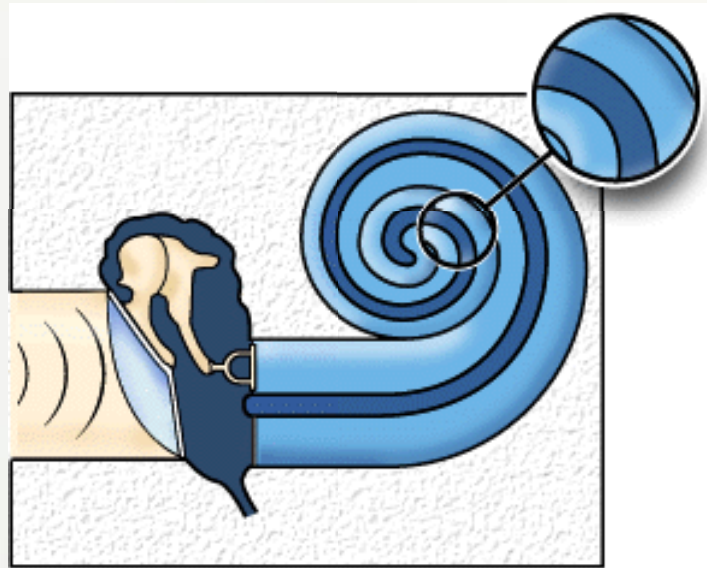
- ❖ På basilarmembranen sitterer ca. **3.000 indre hårceller (IHC)** og ca. **12.000 ydre hårceller (OHC)**.
- ❖ De indre hårceller sitter ordnet i én lang rekke, mens de ytre hårceller er placeret i trekantformationer, i tre rekker.
- ❖ På toppen av cellerne finnes cilier (fimmerhår), hvorav OHC's cilier rager opp i tectorialmembranen.



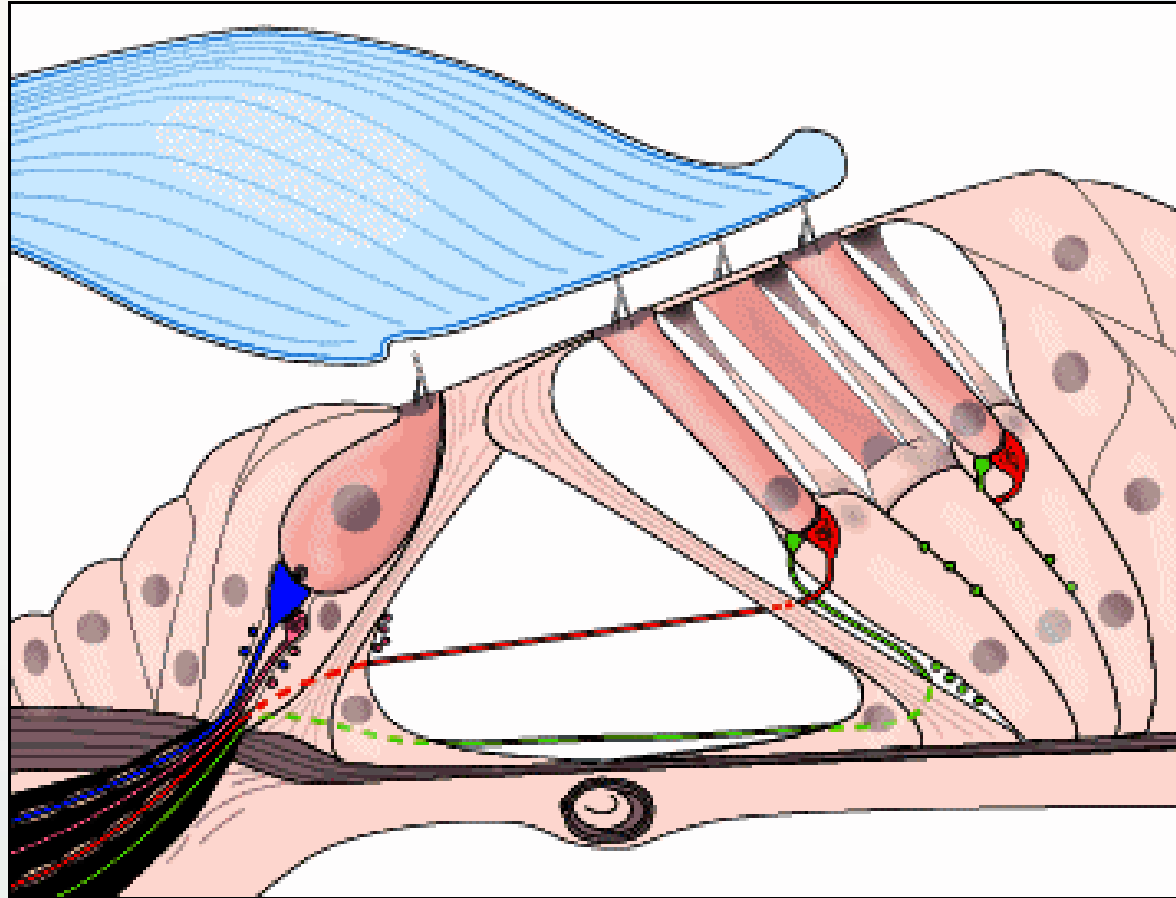
Basilar Membrane Deflections In Response To High Frequency Sound



Basilar Membrane Deflections In Response To Low Frequency Sound



Aktivering av hårceller



Til og fra
hjernen

LINEAR

FREQUENCY

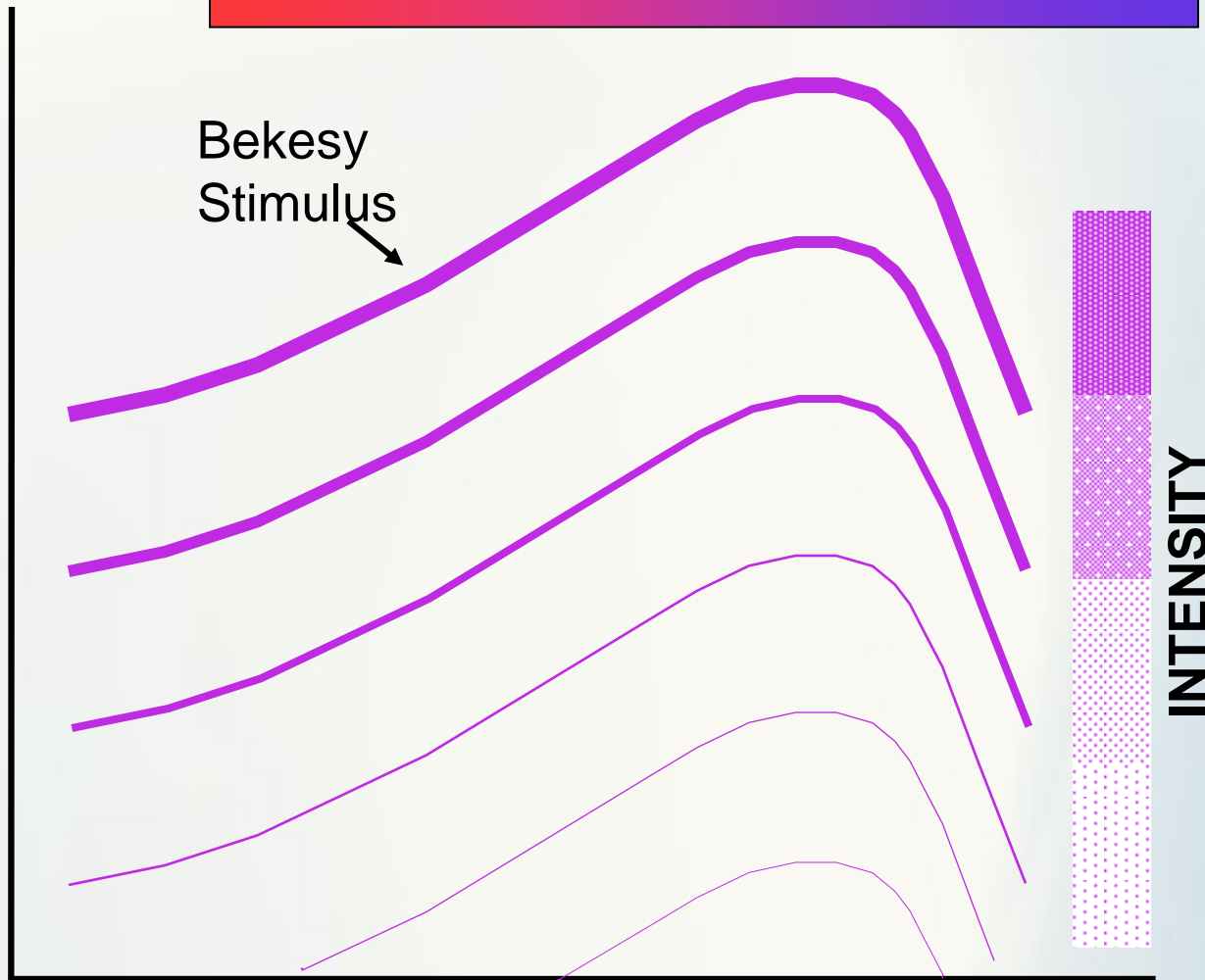
High

Low

BASILAR MEMBRANE DISPLACEMENT



Bekeyes Stimulus



INTENSITY

Base

PLACE

Apex

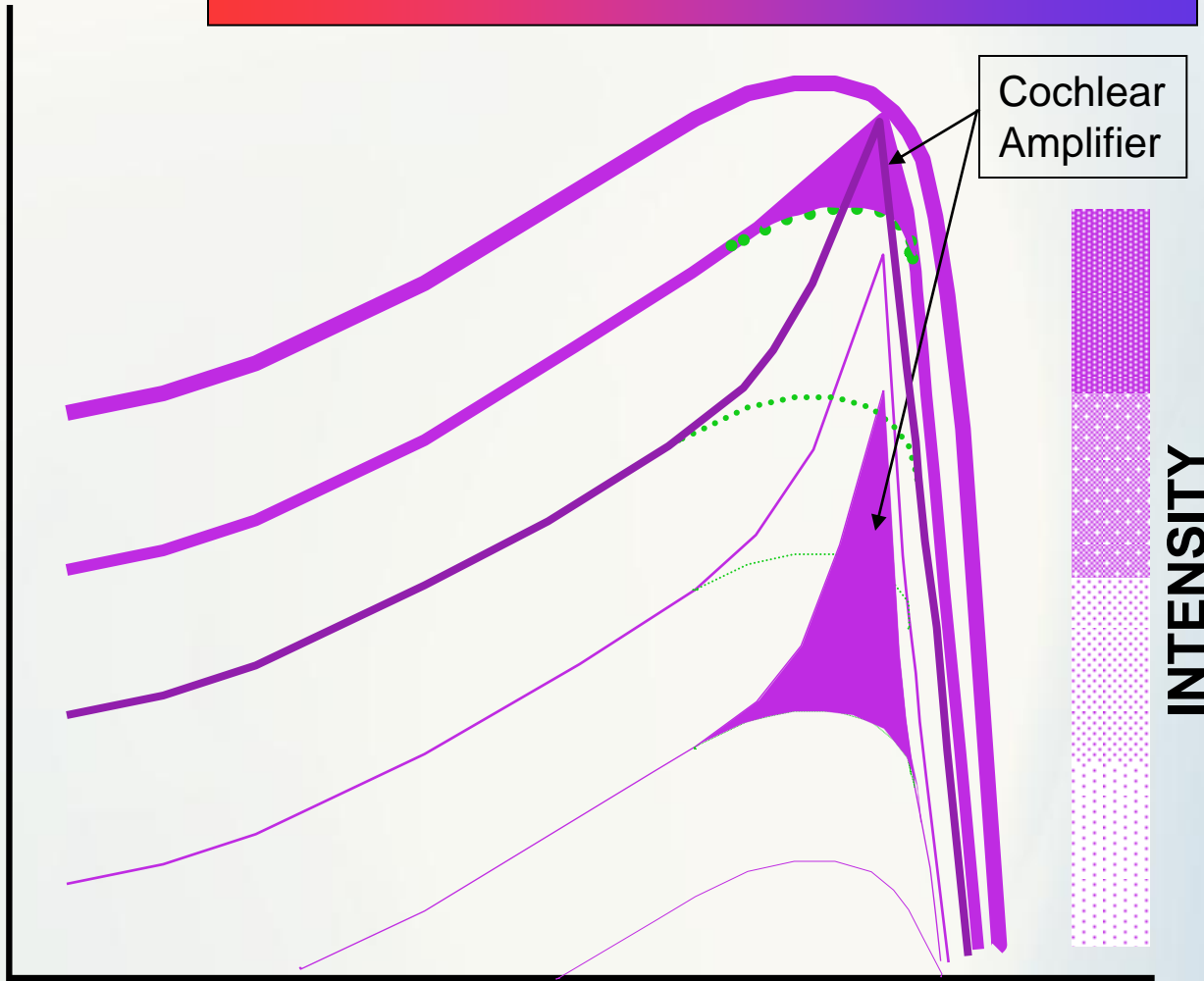
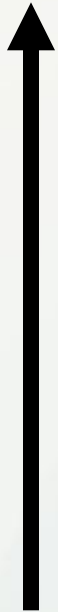
NONLINEAR

FREQUENCY

High

Low

BASILAR MEMBRANE DISPLACEMENT



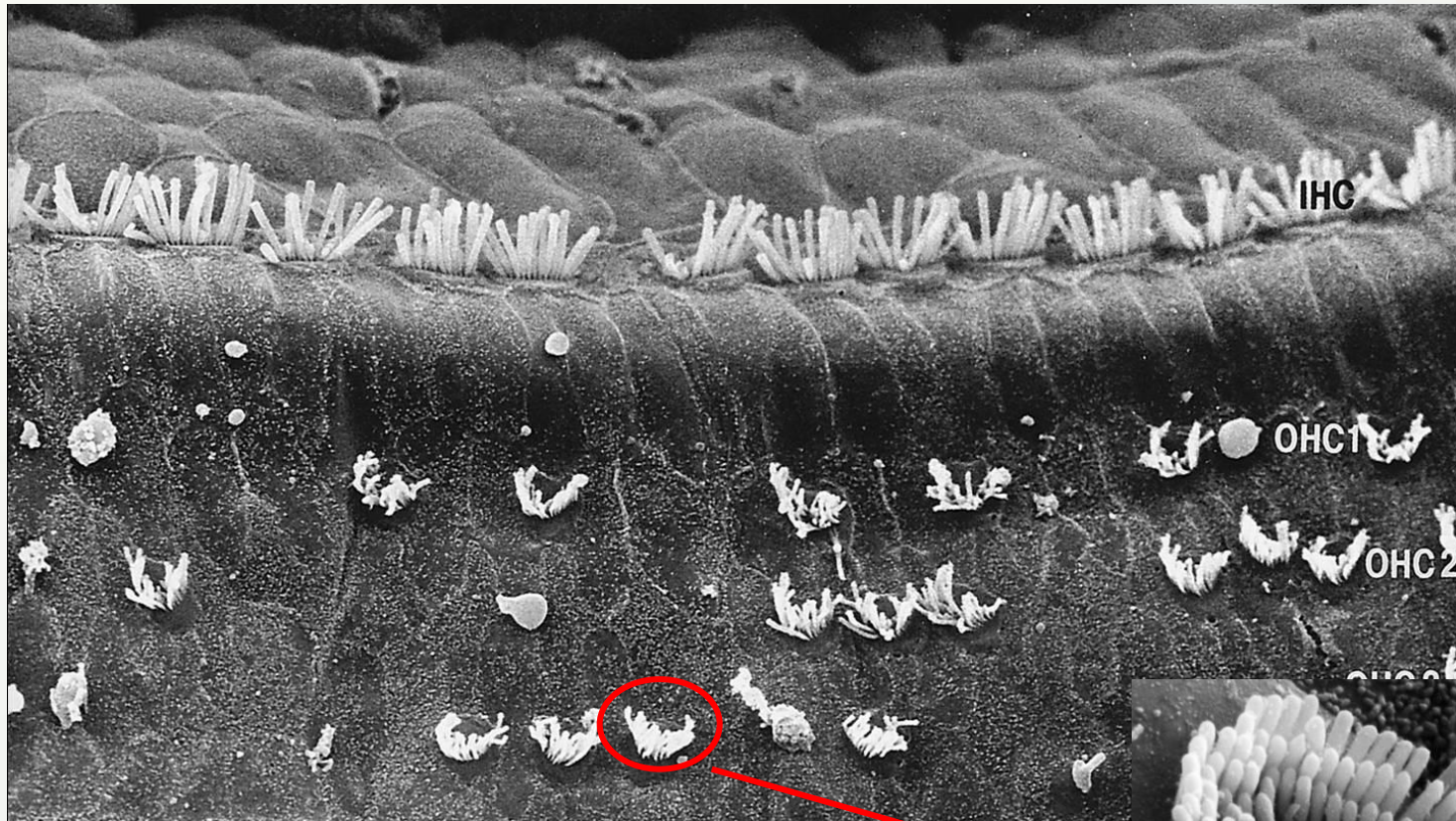
Base

PLACE

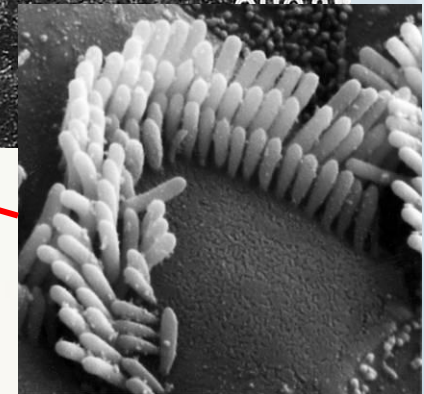
Apex

INTENSITY

Tap av ytre hårceller = tap av høreevne



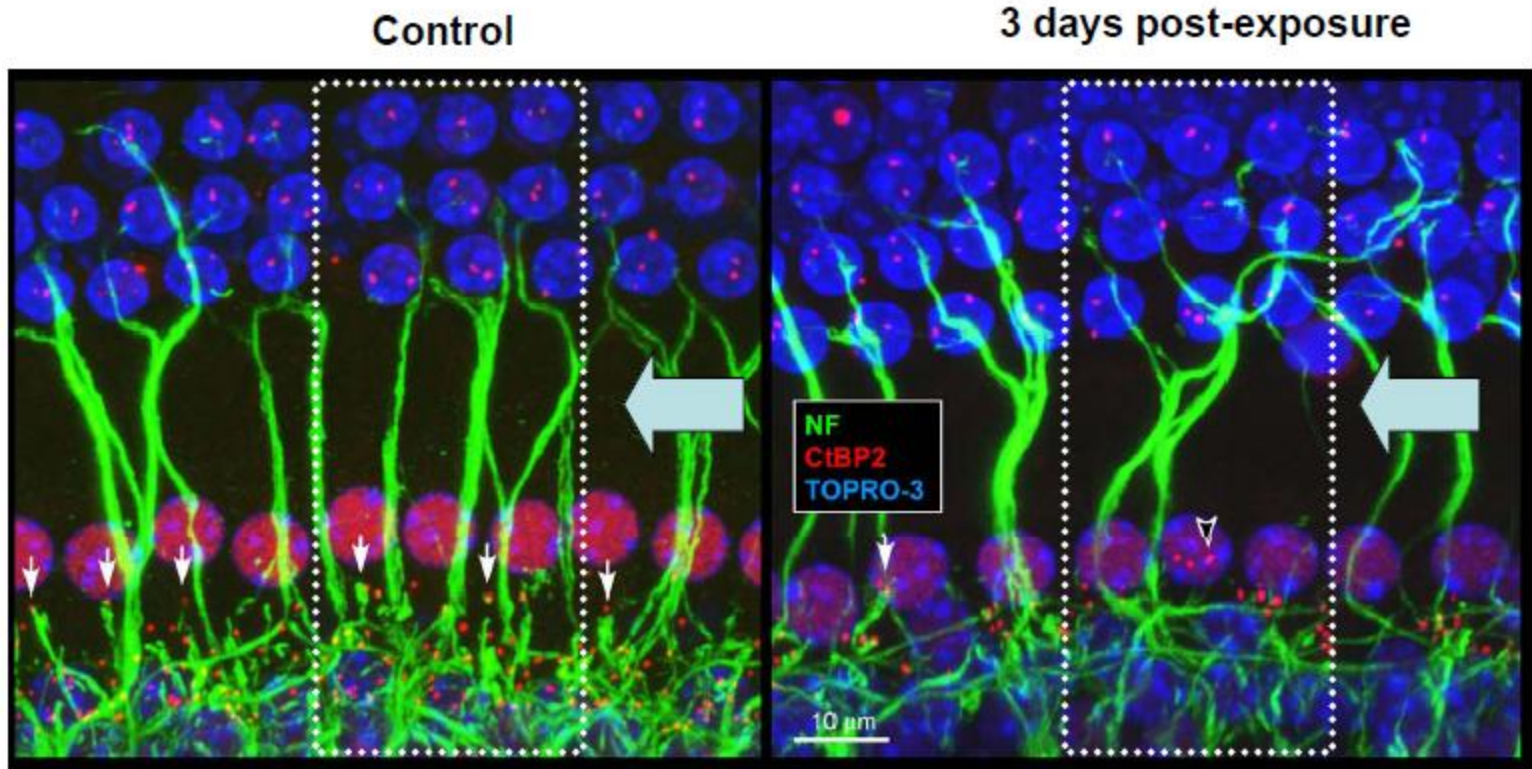
På dette bilde er ytre hårceller ødelagte, mens indre hårceller fremstår mere intakte.



A 100

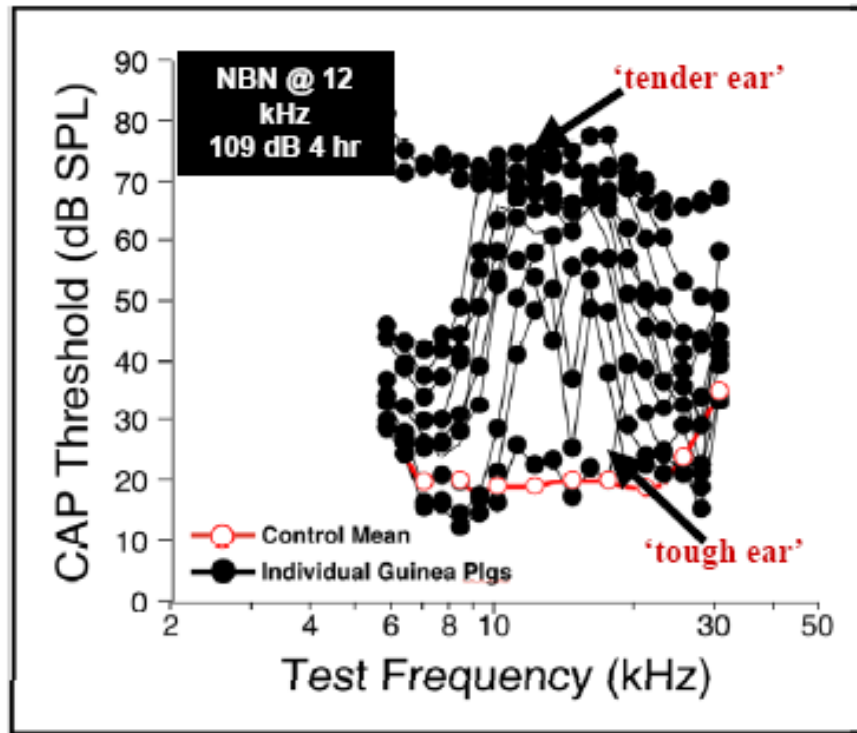
B 100

Rapid IHC dendritic loss after reversible threshold shift

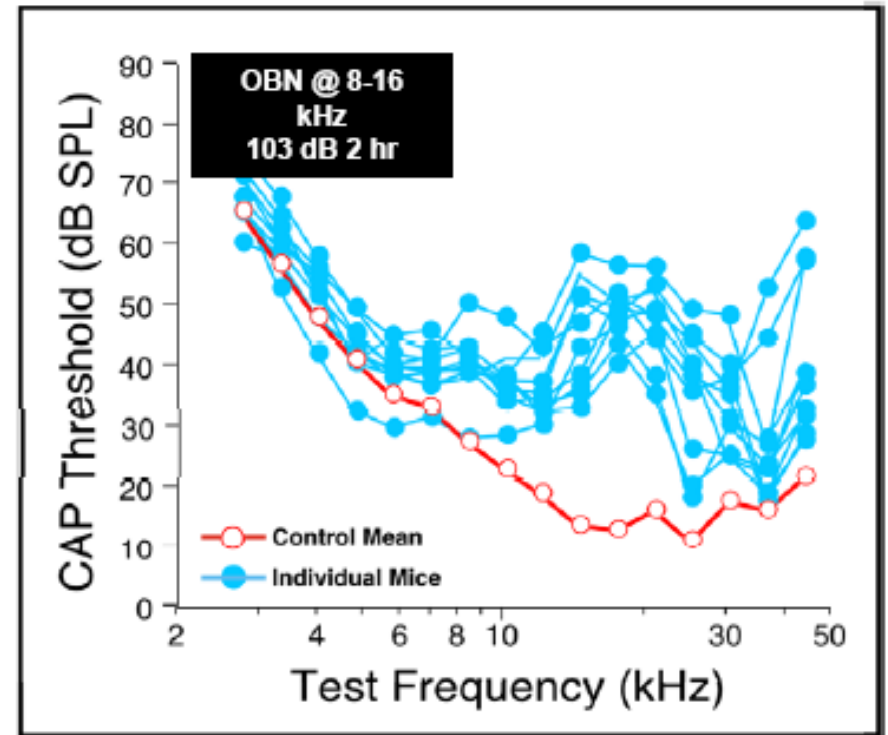


Kujawa & Liberman, 2009

12 identically exposed Guinea Pigs



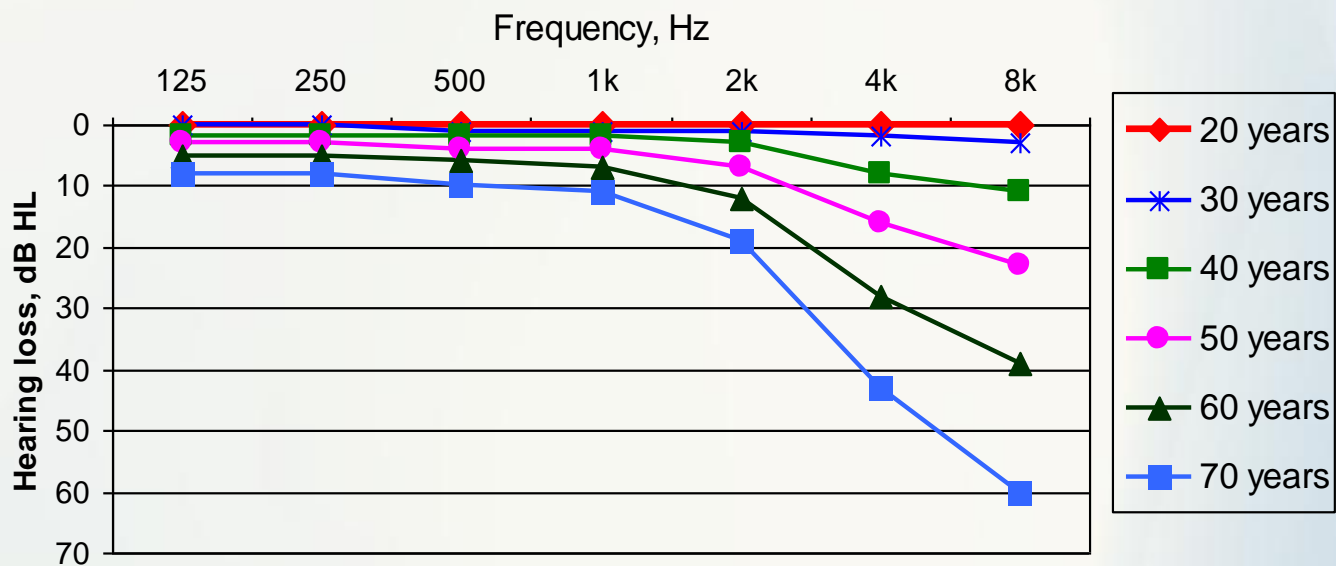
12 identically exposed CBA/CaJ mice



Libermann, J. Neurosci 2000

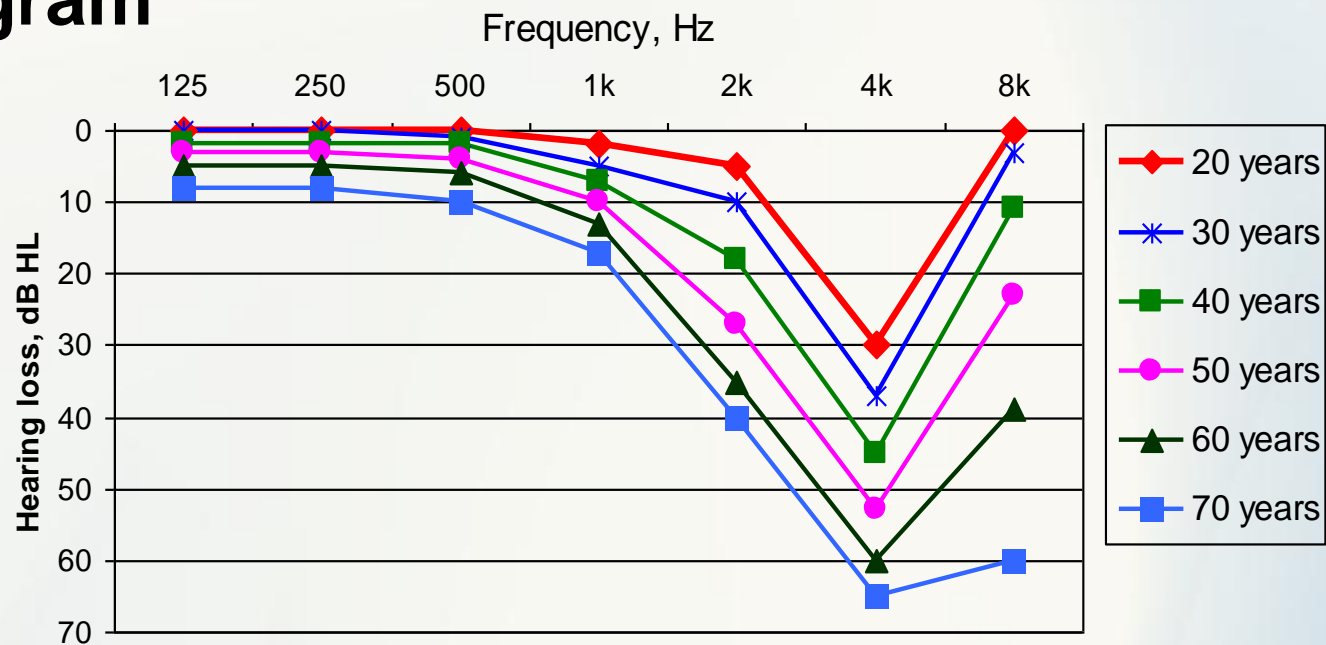
Audiogram

Hørseltap hos menn. Effekt av alder (Median, ISO 7029)



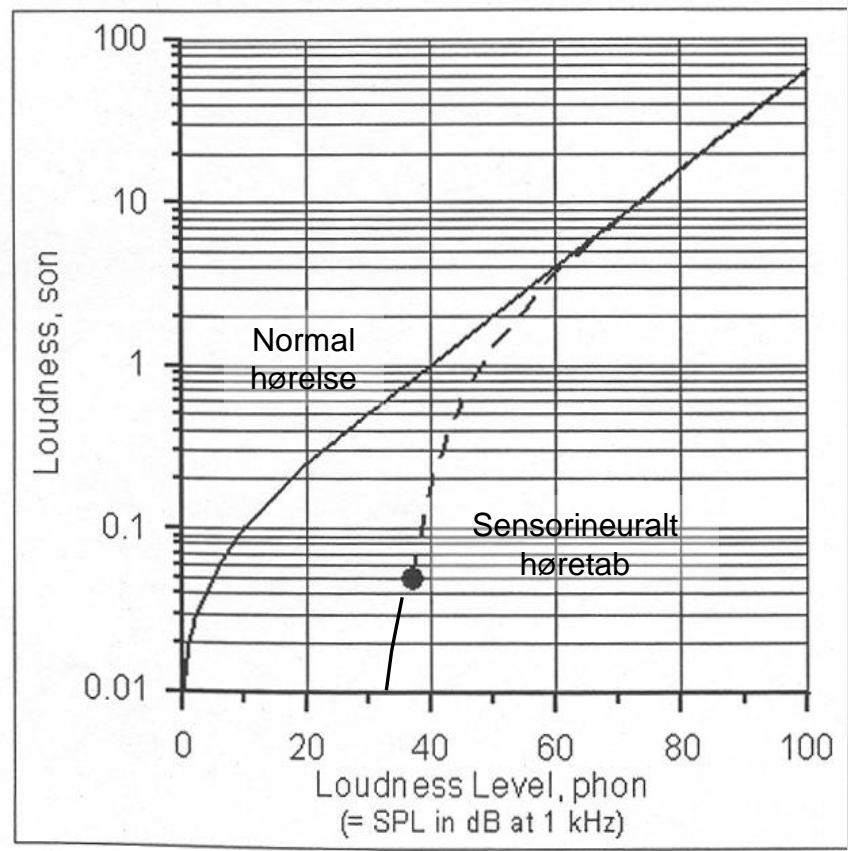
Høreseltap som skyldes støy (ISO 1999)

Audiogram



Normal loudness, Loudness recruitment og Softness imperception

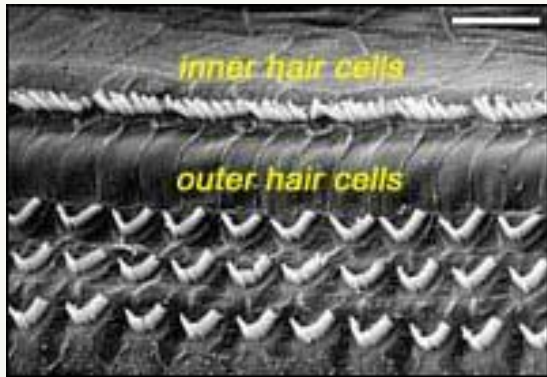
- ❖ Normalthørendes oppfattelse av styrken til 1 kHz tonen kan beskrives som en lineær funksjon (Stevens power law) for nivåer over 20 dB SPL
- ❖ Ved **loudness recruitment**, opplever den hørselhemmede at lydens styrke økes langt hurtigere ved nivåer akkurat over høreterskelen, ift. til den normale loudness-oppfattelse.
- ❖ Begrepet **softness imperception**, betyr at den hørselhemmede mister evnen til å oppleve lyder som svake, når de presenteres rundt høreterskel (Buus & Florentine, 2001).



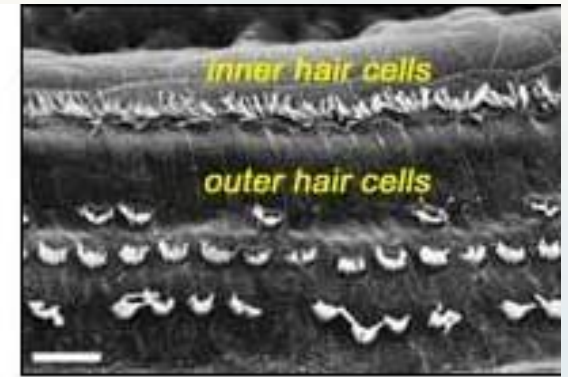
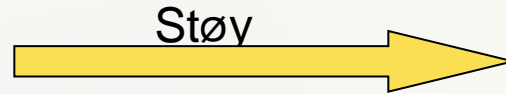
I Europe

- 450millioner (65%) utsatt for støy >55dBA
- 113 million (17%) utsatt for støy >65dBA
- 9.7million (1.4%) utsatt for støy >75dBA

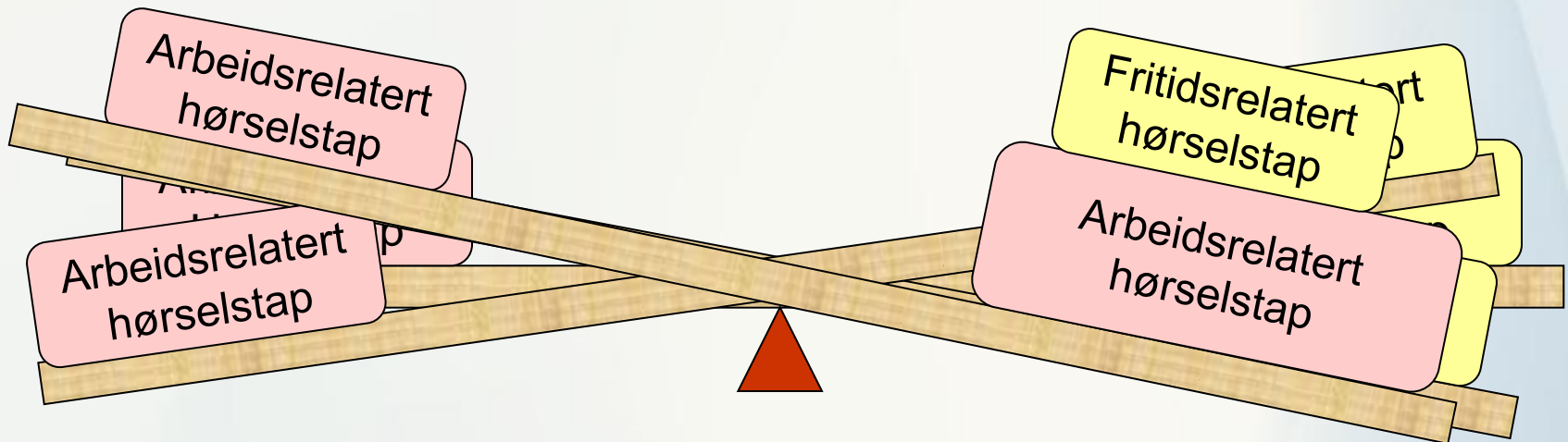
Støindusert hørselsnedsettelse



Normal



Damaged



**Young Adults' Use and Output Level Settings of
Personal Music Systems**

Peter Torre III

Ear & Hearing, Vol. 29, No. 5, 791-799

TABLE 2. The mean age for all participants is shown. The number, and percent, for responses to the questions of the personal music system use survey are also shown

	Mean (SD)	
Age	21.0 (2.4)	
	n	Percent
Do you listen to a personal music system using earphones?—Yes (n = 1016)	930	91.5
Of the 930 participants who answered Yes		
Which system?		
Apple iPod	702	75.6
other MP3 player	81	8.7
CD player	50	5.4
Cell phone	33	3.6
Computer	63	6.8
What style earphones?		
iPod earbuds	541	58.4
non-iPod earbuds	147	15.9
in the canal earphones	138	14.9
over the ear earphones	100	10.8
What setting?		
Exercising	414	44.5
At work	33	3.5
On campus	257	27.6
Trolley/bus	60	6.5
At home	166	17.9

How long?		
<1hr	330	35.5
Between 1 and 3 hrs	447	48.1
Between 3 and 5 hrs	112	12.0
>5 hrs	41	4.4
What volume?		
Very low	6	0.7
Low	51	5.5
Medium	491	53.0
Loud	324	35.0
Very loud	54	5.8
Notice any problem after using personal music system—Yes	106	11.5
Notice any ringing—Yes	147	15.9
Aware that prolonged use of personal music systems at high volumes can lead to hearing loss?—No	104	11.3
Do you feel you have a hearing loss?—Yes	103	11.2



Scientific Committee on Emerging and Newly Identified Health Risks

SCENIHR

Potential health risks of exposure to noise from personal music players and mobile phones including a music playing function



The prevalence of tinnitus (or ringing in the ear) in noise-exposed populations seems to be much higher than in general populations. It has been estimated at prevalence 37% for less than 10 years of exposure and 50% for 11-30 years of exposure to noise. Noise-

Tinnitus

Opplevelse av en lyd som helt og holdent har sin opprinnelse i aktivitet i nervesystemet, uten noen korresponderende mekanisk, vibrerende aktivitet i cochlea, og uten at det er knyttet noen form for ekstern stimulering til den

Hyperacusis

En overfølsomhet overfor alle ytre lyder over en viss intensitet på grunn av en unormal styrkeoppfattelse (“abnormal loudness perception”) med økt sentral auditiv forsterkning. Ikke nødvendigvis forbundet med cochleær skade; ses ofte sammen med tinnitus.

Fonofobi

Angst for visse lyder

Tyler, 2000

Fysisk ubehag overfor visse lyder uten relasjon til lydstyrke og med normal toleranse overfor andre lyder. Sterke fobiske reaksjoner involverer det limbiske og det autonome nervesystem og ledsages av urokkelige oppfatninger om lyd og skade. Fenomenet er ikke knyttet til hørseltap

Sheldrake, 2001

Misophonia

”Negativ holdning til lyder, inkludert frykt”
Jastreboff 2002

112 tinnituspatienter

støyskade	35
aldersdøvhet	19
innerøreskade	19
Menieres sykdom	8
støy + alder	6
arvelig innerøresykdom	5
kronisk ørebetennelse	5
sudden deafness	3
ototoxisk skade	2
otosklerose	2
normal hørsel	8

Tinnitusepidemiologi



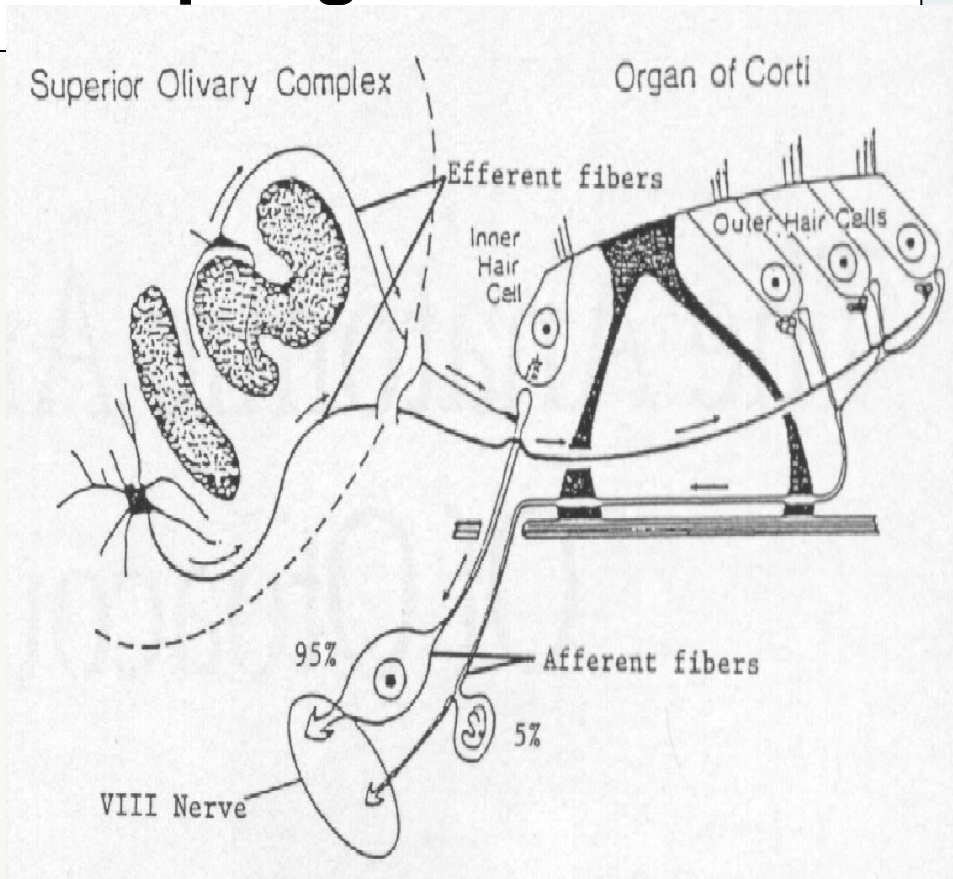
10-15 % av befolkningen har
tinnitus ”ofte eller alltid”
1-3 % har store problemer

TABLE 3-2. Prevalence of Self-Reported Tinnitus in Adults by Decade of Life from Several Population-Based, Epidemiologic Studies

<i>Age, yr</i>	<i>United Kingdom National Study of Hearing* (1980–1986), %</i>	<i>Gothenburg, Sweden† (1989), %</i>	<i>US NHIS Hearing Supplement‡ (1990), %</i>	<i>US NHIS Disability Supplement§ (1994–1995), %</i>	<i>Beaver Dam, WI Hearing Loss Study (1993–1995), %</i>	<i>Nord Trøndelag, Norway Hearing Loss Study¶ (1996–1998), %</i>
20–29	5.7	7.5	5.1	1.4	—	9.8
30–39	7.4	5.8	6.0	2.0	—	9.6
40–49	9.9	8.9	7.2	3.7	—	11.8
50–59	12.5	18.6	10.1	5.7	7.3	16.9
60–69	16.3	20.3	13.0	7.9	10.1	20.2
70–79	14.4	21.3	12.6	9.4	8.7	24.0
≥ 80	13.6	—	14.1	8.3	5.5	22.9
Age ≥ 50	14.2	20.1	12.1	7.6	8.2	20.1
Total adult	10.2	14.2	8.4	4.4	—	15.1
No. in study	34,050	2,556	59,343	99,435	3,737	47,410

Indre og ytre hårcellers kopling

- En rad med indre hårceller med hovedsakelig afferente fibre
- Tre rader med ytre hårceller med hovedsakelig efferente fibre



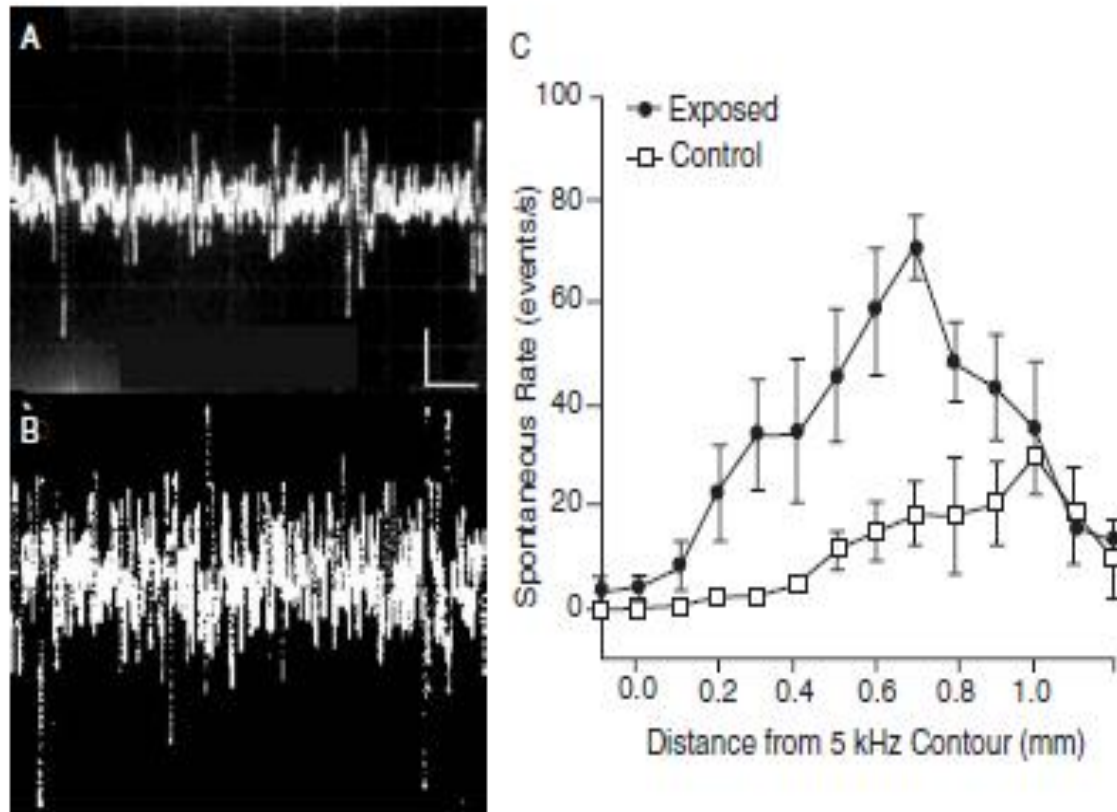


FIGURE 11-3. A comparison of spontaneous activity in control and tone-exposed animals. A, Oscillographic trace showing spontaneous activity recorded at the 10 kHz locus of the dorsal cochlear nucleus (DCN) of a control animal. B, Spontaneous activity recorded at the corresponding locus of an animal that had been exposed to a 10 kHz tone (125 dB SPL, 4 hours) 1 month previously. C, Topographic profiles of mean activity recorded on the DCN surface in control (*lower curve*) and tone-exposed (*upper curve*) animals. Adapted from Kaltenbach JA and McCaslin DL⁵¹ and Kaltenbach JA and Afman CE.⁵³

Kaltenbach et al 2004

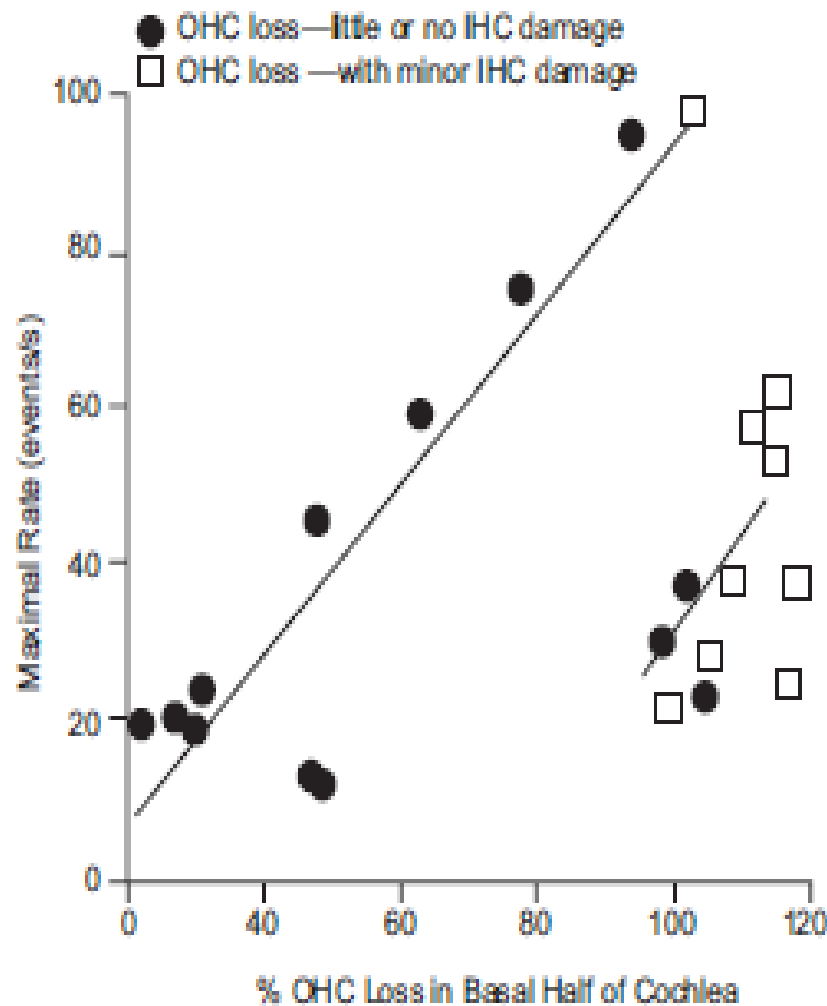


FIGURE 11-7. The relationship between the level of peak activity in the dorsal cochlear nucleus and the amount of outer hair cell (OHC) loss induced in hamsters after receiving five injections, one every other day, of cisplatin (3 mg/kg/d). Note that there was a systematic increase in activity as a function of OHC loss up to approximately 80% OHC loss in the basal half of the cochlea. Above this range, activity showed a sharp reduction. In the range above 80%, OHC loss was associated with significant damage to inner hair cells (IHCs). The curves suggest that OHC loss may be a trigger of hyperactivity, but this hyperactivity may be reversed by damage to IHCs. Adapted from Kaltenbach JA et al.⁷⁹

Kaltenbach et al 2004

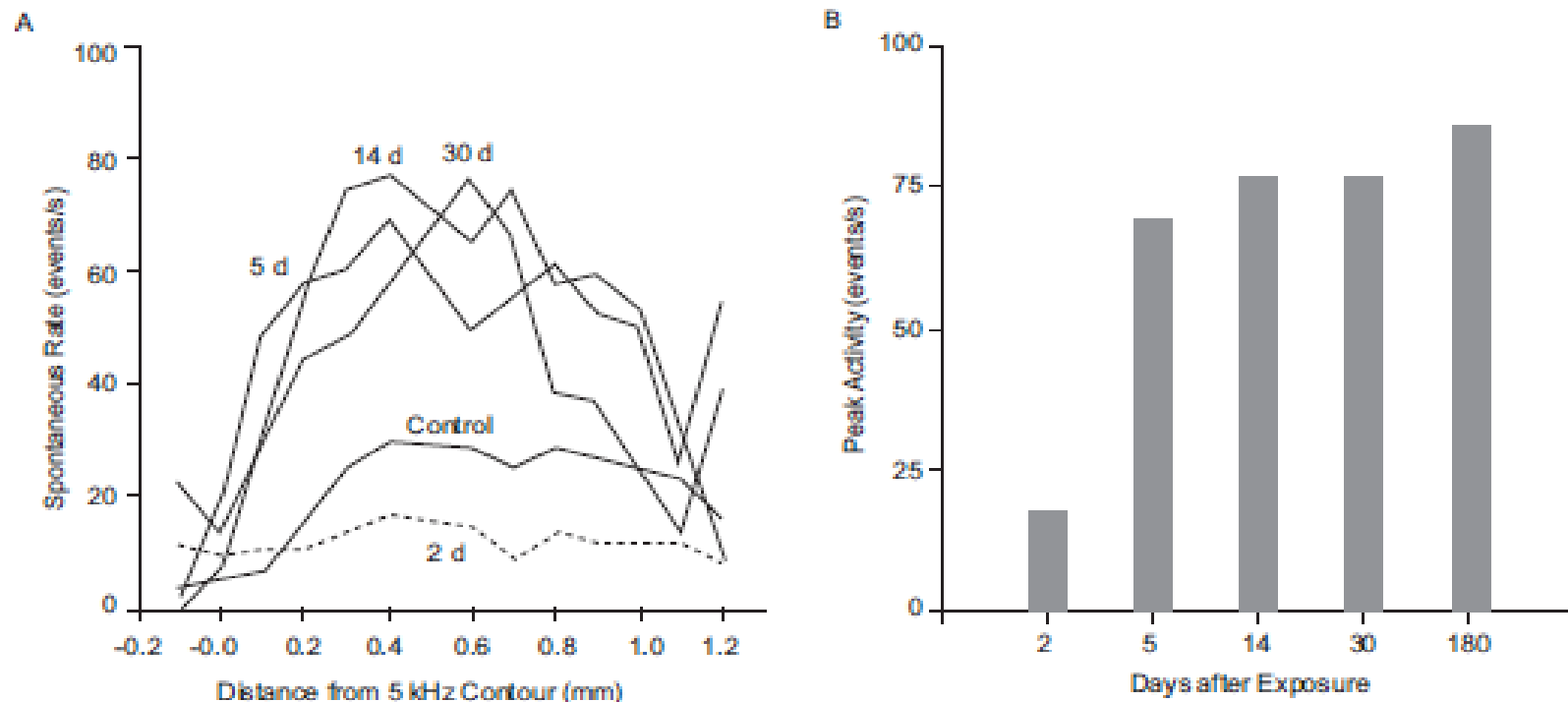
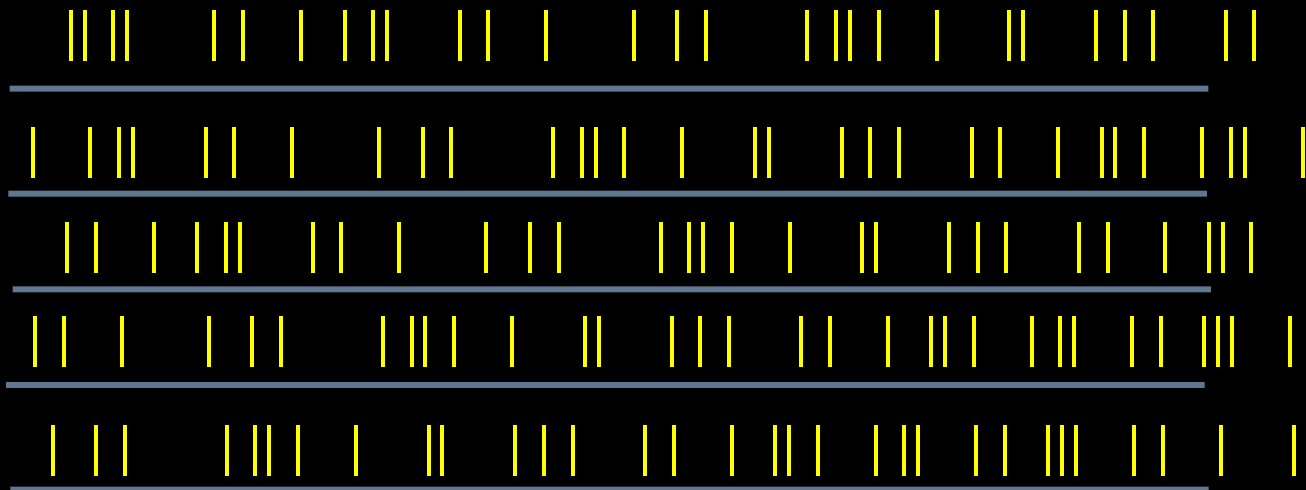


FIGURE 11-8. Evidence that plasticity underlies the induction of hyperactivity in the dorsal cochlear nucleus (DCN) by intense sound exposure. *A*, For the rather extreme exposure conditions (10 kHz, 125–130 dB SPL, 4 hours), the profile of activity observed across the DCN depends on the postexposure recovery time. Activity recorded 2 days after exposure was depressed below control levels, whereas at all subsequent times, the activity was distinctly higher than control levels. The profile at 5 days shows a broad distribution of hyperactivity across most of the DCN. This profile transformed into one with a more narrowly defined peak at 30 days after exposure. An intermediate profile was observed at 14 days after exposure. *B*, Peak activity increased most dramatically between 2 and 5 days after exposure. These results demonstrate that the distribution of hyperactivity is shaped by plastic readjustments in the DCN over many weeks after exposure. Adapted from Kaltenbach JA et al.⁸⁰

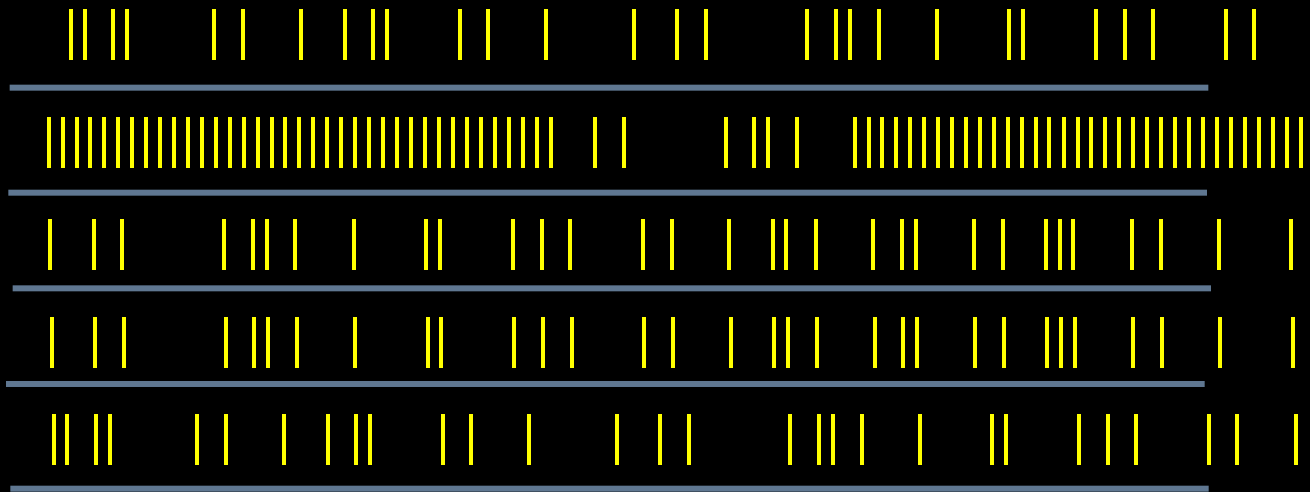
Kaltenbach et al 2004

Ø
R
E

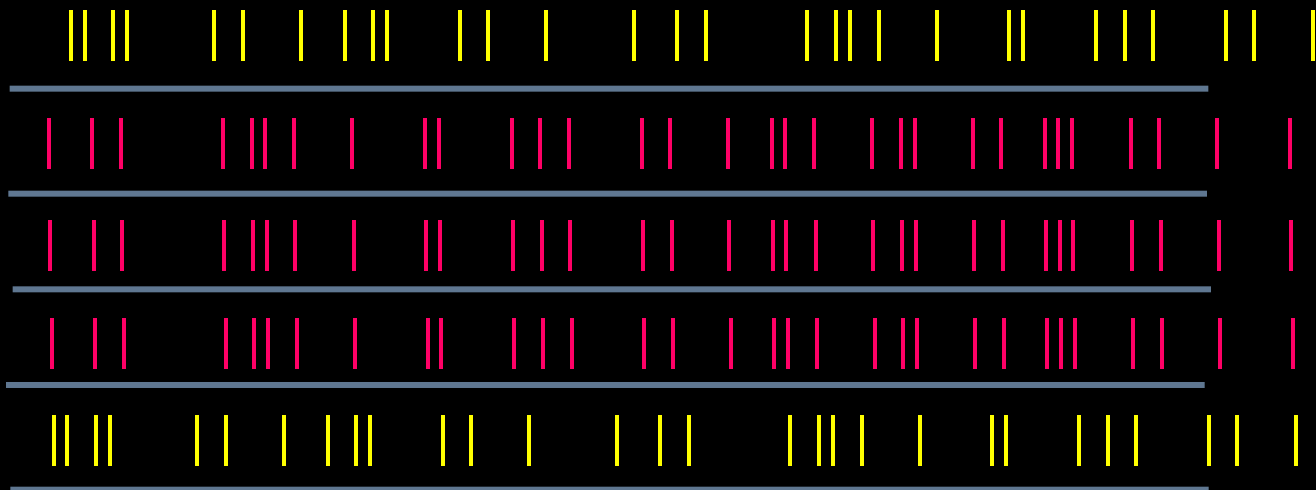


C
O
R
T
E
X

Tilfeldig aktivitet = stillhet



Eksterne lyder – synkronisert firing
Mangel på tilfeldig aktivitet
Lyd mottatt på cortex



Mangel på neural "isolering"
Synkronisert bakgrunnsaktivitet
-> "cross talk"
Tinnitus registrert

Möllers hypotese 1984

Kilder til tinnitus

Disco tinnitus

80% får en TEMPORÆR tinnitus

Tinnitus hos normalthørende personer

Heller & Bergman 1953

Ann. Otol 62:73-83

- 80 voksne , ingen hns eller tinnitus
- i lydisolert rom i < 5 minutter
- skulle registrere alle hørbare lyder
- 94% registrerte tinnitus

Hørselsnedsettelse og tinnitus

- 70 – 90 % av tinnitus plagede har en signifikant hørselsnedsettelse
- For en gitt grad av "tinnitus annoyance" så har folk en større hørselsnedsettelse

Davies og Rafaie, 2000

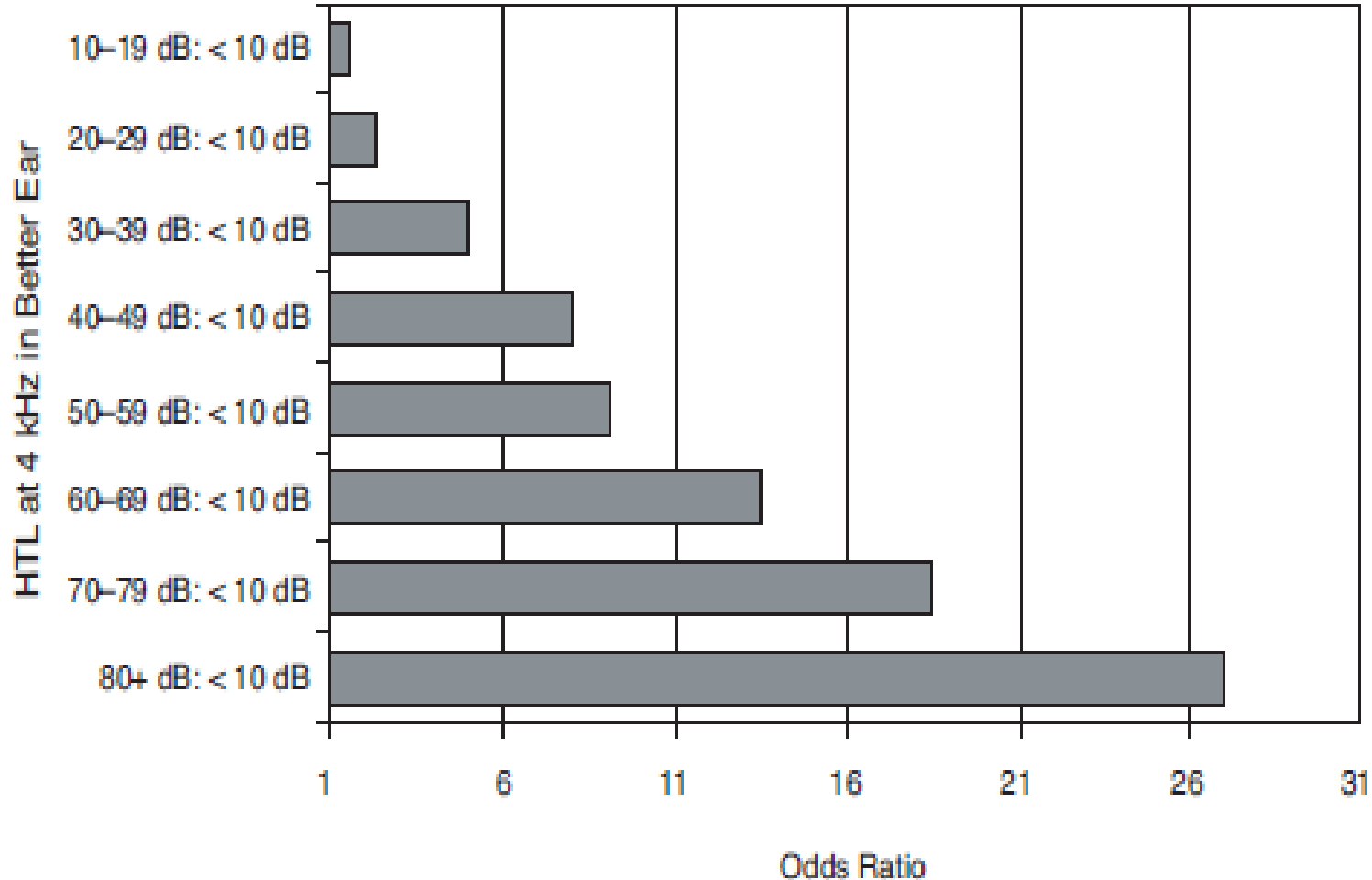
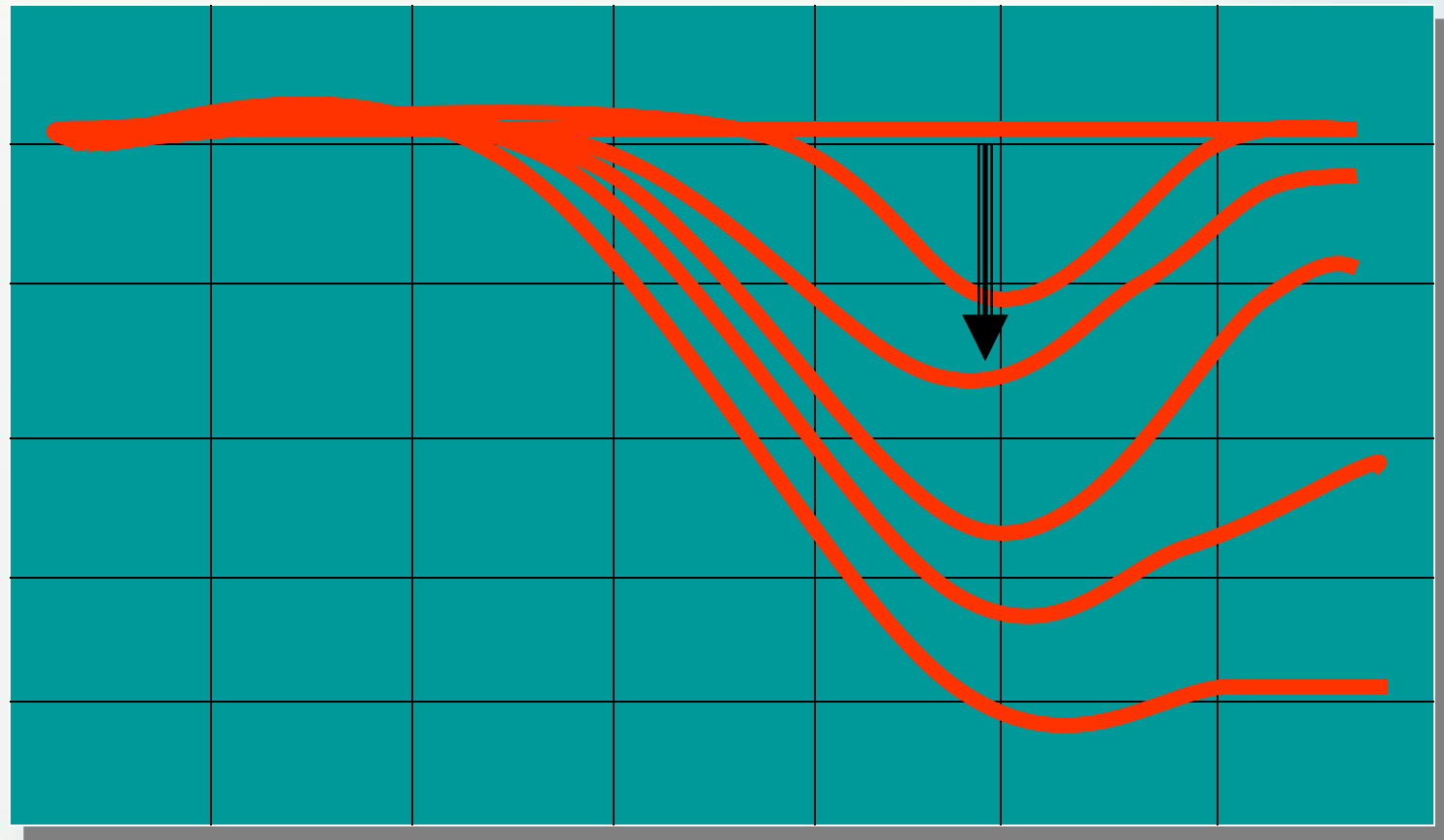


FIGURE 1-1. Bar graph showing how the odds of having tinnitus increase as hearing threshold level (HTL) at 4 kHz creases in the United Kingdom National Study of Hearing. Because the prevalence of tinnitus in people with 4 kHz thresholds less than 10 dB (the reference group) was about 1%, the odds ratios in this case are very close to the actual prevalence rates in percent. Reproduced with permission from Coles R.³

”Noise-induced hearing loss causes a reorganization of the cortical tonotopic map and increased firing rate and neural synchrony. If acoustic stimulation with a spectrum corresponding to the frequency band of the hearing loss is provided after the trauma, however, the hearing loss is reduced, the tonotopic map is normal, and the spontaneous firing rate and synchrony are unchanged.”

Tinnitus og hørselsnedsettelse



Maskere

- Fullstendig maskering
Kan ikke høre tinnitus
- Partiell maskering
Tinnitus hørbar men redusert i styrke

Tinnitusevaluering

1) Identifisering

Pitch matching

Loudness matching

2) Maskeringstest

MMN

3) Residual Inhibisjon

MMN + 10 dB

MMN + 20 dB

Høreapparat for tinnitus

- Forbedrer kommunikasjon
Reduserer stress
- Forsterker bakgrunnsstøy
Maskering, Habituering
- Produserer støy
Maskering, Habituering

ReSoundAIR® /
ReSoundAIR Plus™

Produktbeskrivelse

Først kom den originale ReSoundAIR. Nå kommer ReSoundAIR Plus. Med nytt tilpassingsprogram og mer forsterkning kan enda flere nytte godt av markedets mest komfortable og ettersparte høreapparat. Med ReSoundAIR Plus har du nå to løsninger i ett apparat. Med et enkelt klikk i Aventa 1.7 kan du enten velge:

- Maksimal komfort med 0 % okklusjon og inntil 50 dB forsterkning, med ReSoundAIRs standard øreplugg. (ReSoundAIR) eller
- 55 dB maksimal forsterkning og minimal okklusjon, med den nye ørepluggen Tullp-Dome™. (ReSoundAIR Plus).

ReSoundAIR / ReSoundAIR Plus
nøkkelegenskaper

- WarpOpen™ wide dynamic range compression (FIR-filter)
- Stabilizer™ digital feedbackreduksjon
- Superhurtig signalbehandling
- Hurtigvirkende multibånd støyreduksjon
- Low-level expansion
- Directional microphone system
- Teknologi utviklet for åpne tilpassinger

Standard konfigurasjon

- SmartStart funksjon
- Batterikuff som AMP/A knapp
- Batteristørrelse 10A

Velg

- 5 forskjellige farger på huset
- Lydbølger og øreplugg i ulike størrelser

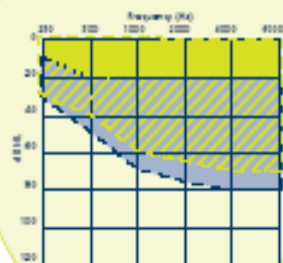


Standard øreplugg



Tullp-Dome™

Tilpassingsområde



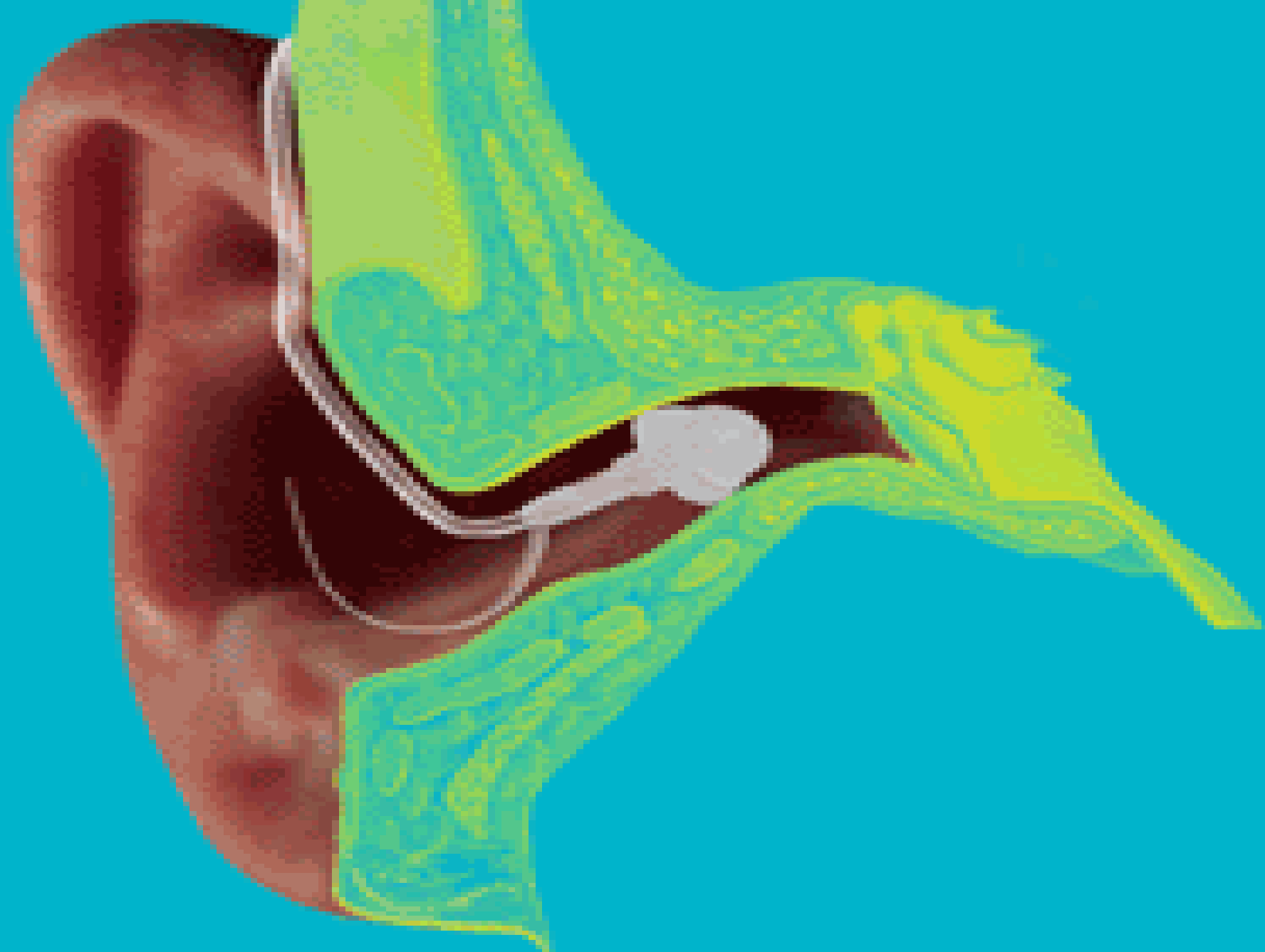
HØYTEKNOLOGISK LEDER

Takk for våre 3400 dedikerte medarbeidere er GN ReSound en av verdens største høreapparatprodusenter med en tradisjon for innovasjon og teknologisk utvikling. Med det prisbelønnede ReSoundAIR fører vi tradisjonen videre. Med innovativ digital teknologi, åpne tilpassinger og en rekke ulike hardware og software teknologier, får vi nok en gang ledelsen innen høreomsorgen.

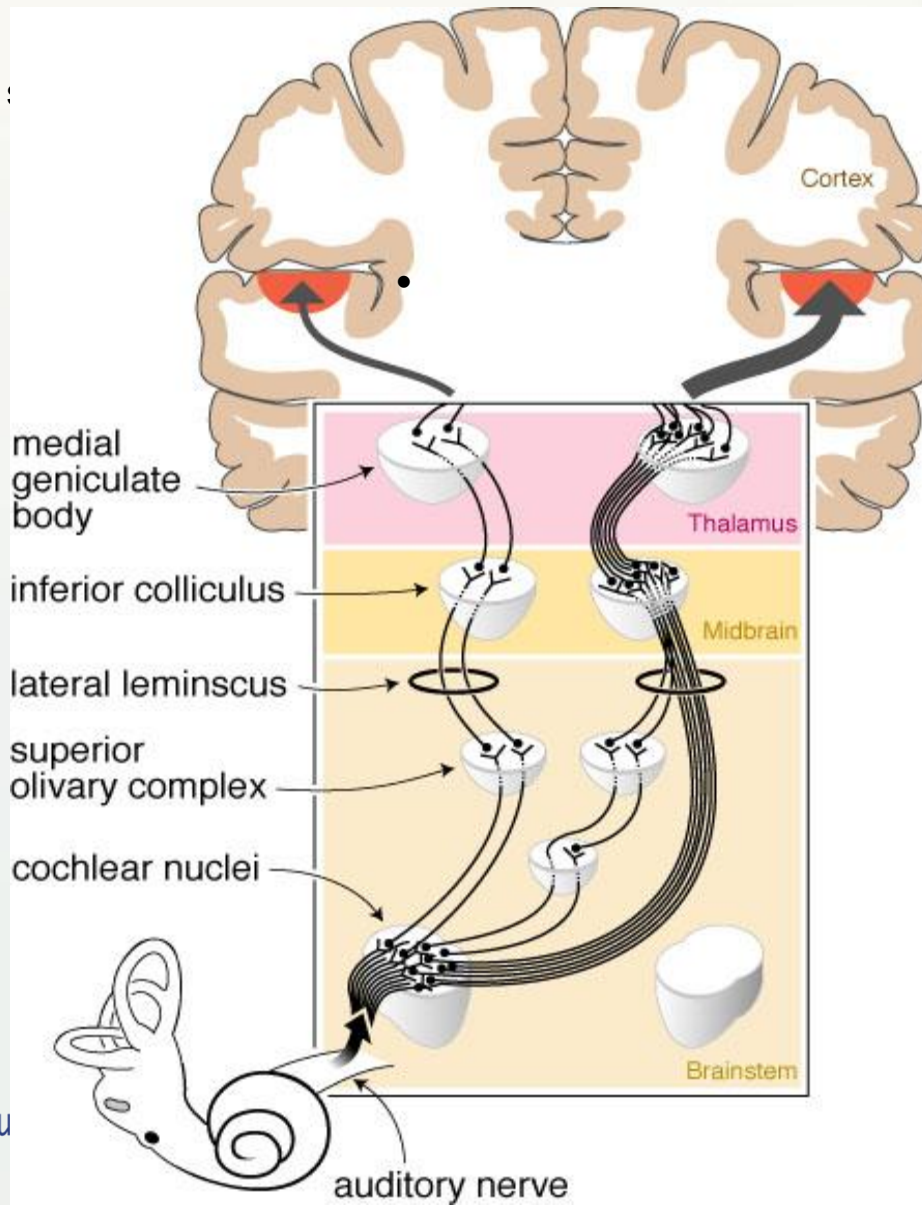
For mer informasjon om ReSoundAIR og ReSoundAIR Plus, kontakt GN ReSound AS, Norge.

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ReSound *AIR*™ReSound *AIR*™



IV. Central auditory :



Jastreboffs Nevrofysiologiske Modell



Neuroscience Research, 8 (1990) 221-254
Elsevier Scientific Publishers Ireland Ltd.

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NEURES 00367

Review Article

Phantom auditory perception (tinnitus): mechanisms of generation and perception

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(Received 10 January 1990; Accepted 25 March 1990)

Key words: Tinnitus; Theory; Mechanisms; Generation; Perception

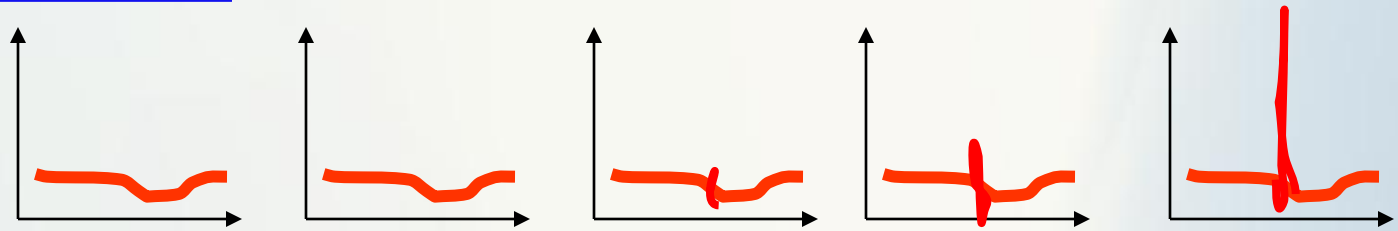
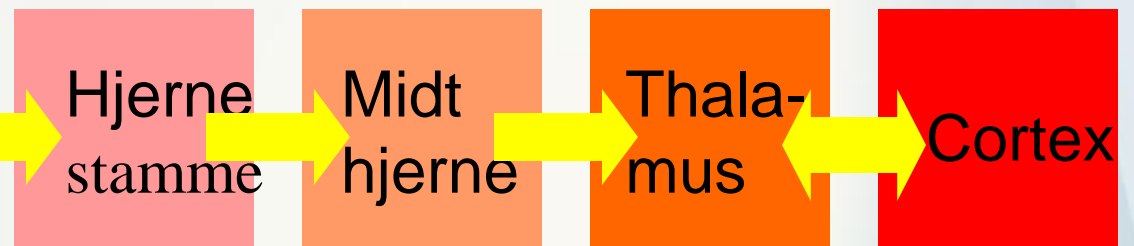
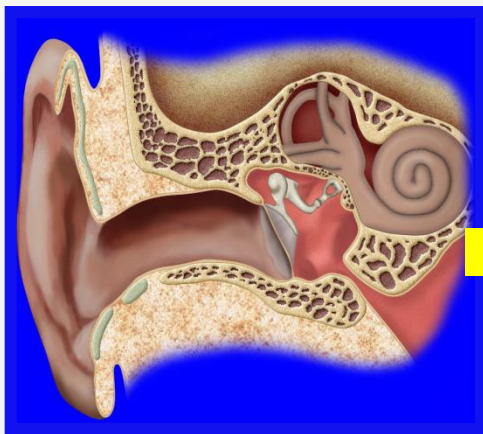
SUMMARY

Phantom auditory perception - tinnitus - is a symptom of many pathologies. Although there are a number of theories postulating certain mechanisms of its generation, none have been proven yet. This paper analyses the phenomenon of tinnitus from the point of view of general neurophysiology. Existing theories and their extrapolation are presented, together with some new potential mechanisms of tinnitus generation, encompassing the involvement of calcium and calcium channels in cochlear function, with implications for malfunction and aging of the auditory and vestibular systems.

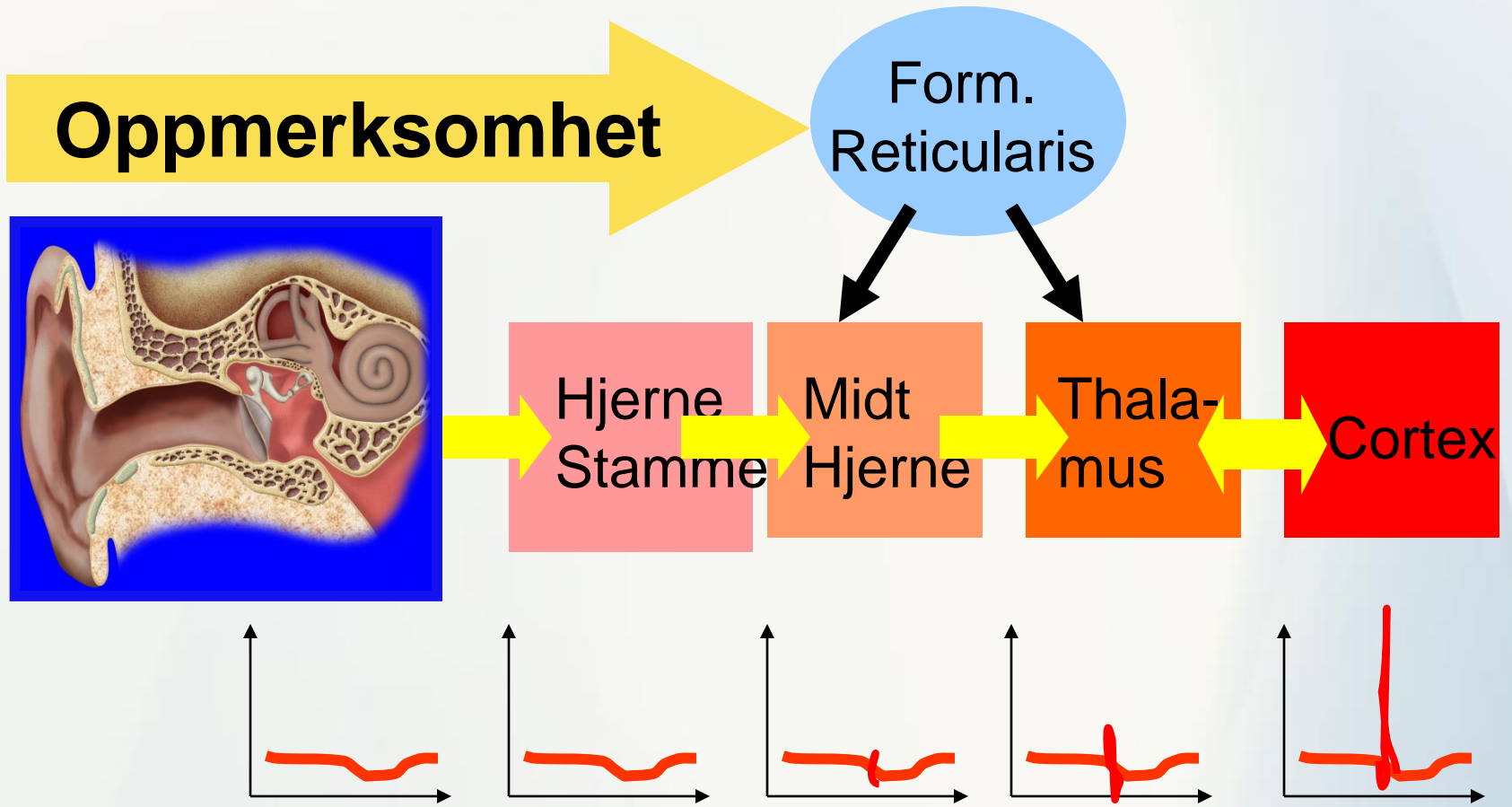
It is hypothesized that most tinnitus results from the perception of abnormal activity, defined as activity which cannot be induced by any combination of external sounds. Moreover, it is hypothesized that signal recognition and classification circuits, working on holographic or neuronal network-like representation, are involved in the perception of tinnitus and are subject to plastic modification. Furthermore, it is proposed that all levels of the nervous system, to varying degrees, are involved in tinnitus manifestation. These concepts are used to unravel the inexplicable, unique features of tinnitus and its masking. Some clinical implications of these theories are suggested.

Neuroscience Res: (1990) 8 221-254

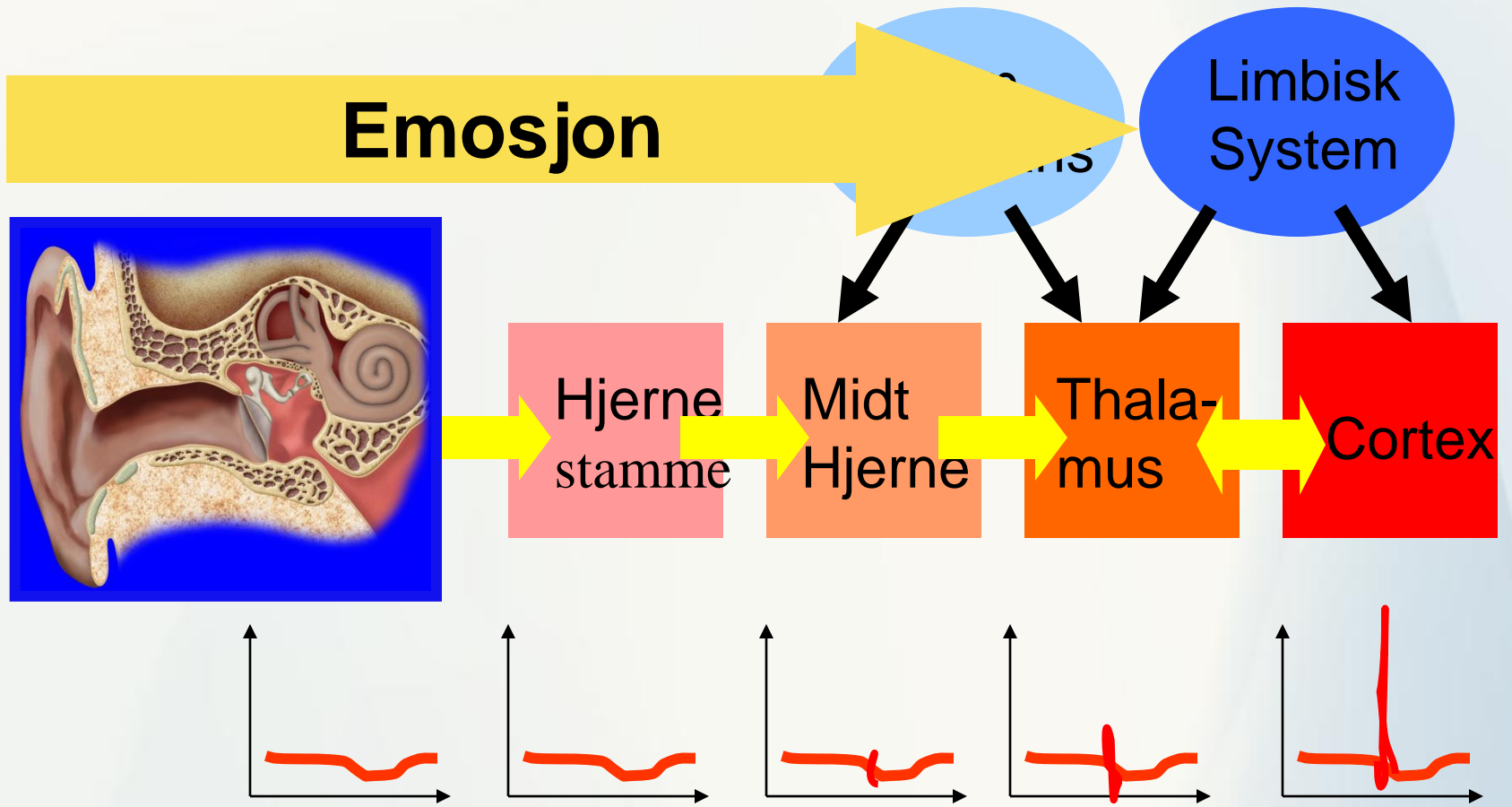
Tinnitus og hørselsnedsettelse



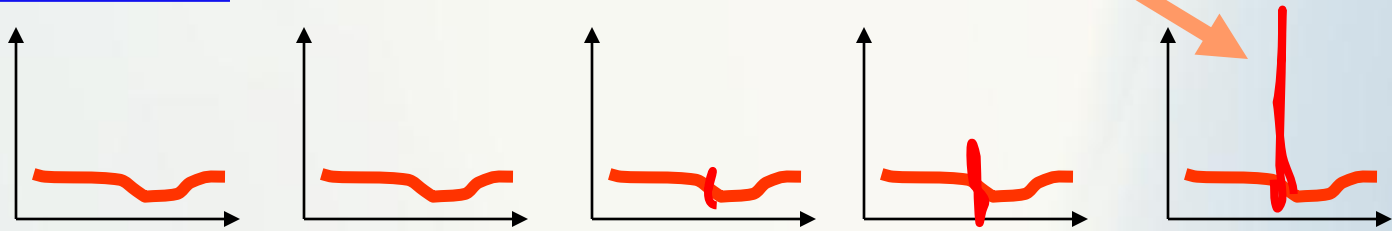
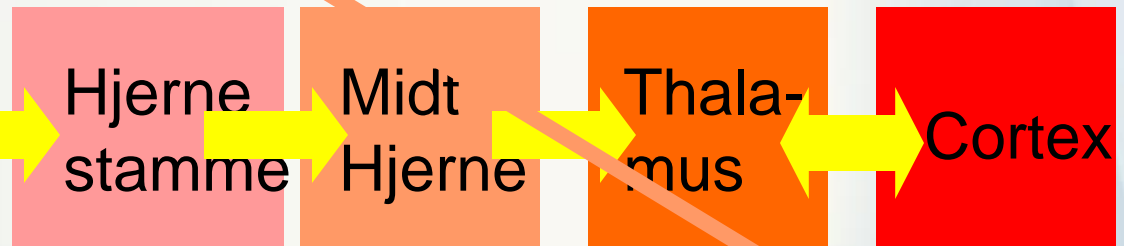
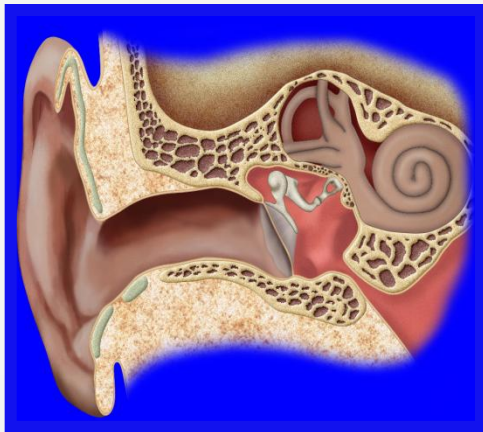
Tinnitus og hørselsnedsettelse



Tinnitus og hørselsnedsettelse



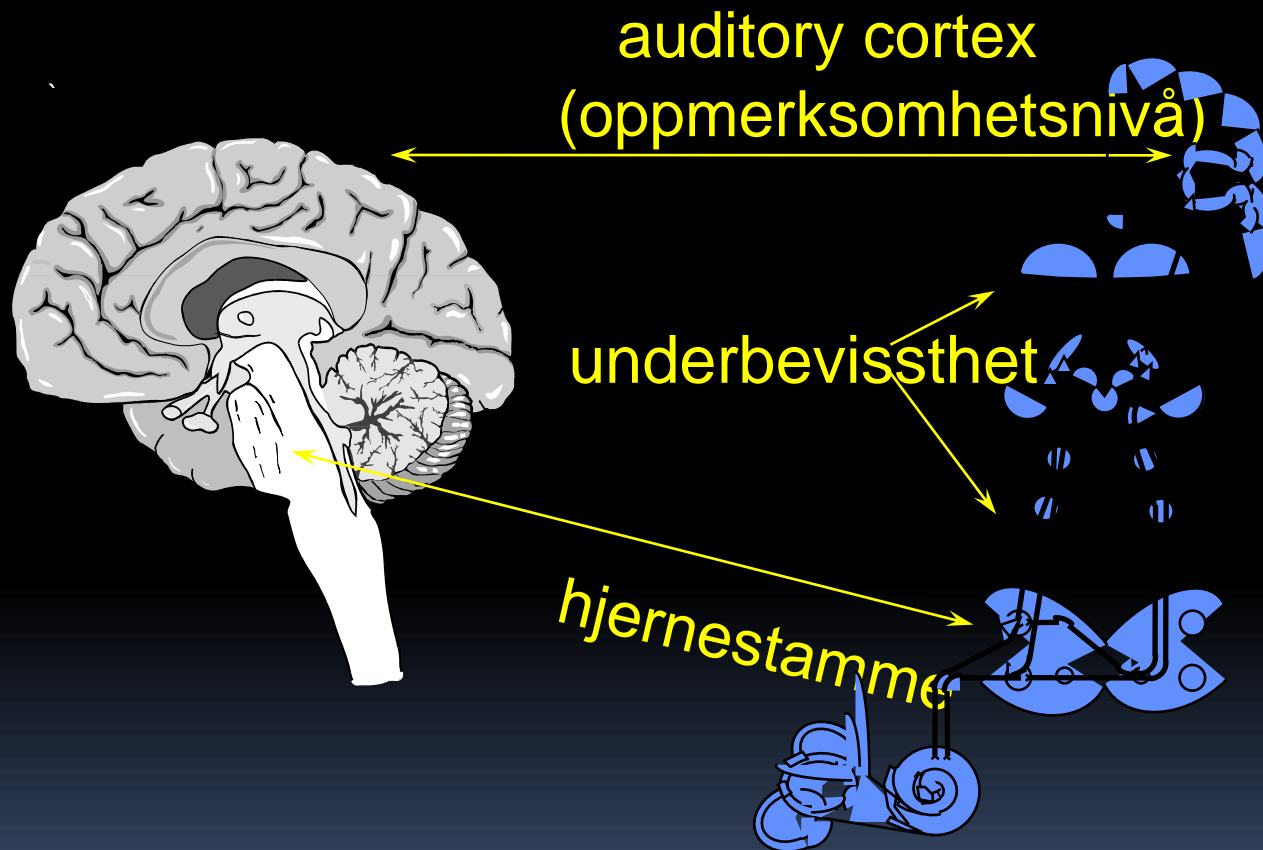
Tinnitus og hørselsnedsettelse



Grunnlag

- Tinnitusen involverer ulike hjernestrukturer ikke bare hørselsbanene
- Hørselstapet resulterer i redusert input til det auditive systemet
- Systemet kompensere ved å øke følsomheten
- Aktivitetsmønstre etableres i hjernen (plastisitet)
- Hjernen skal habituere til tinnitusen

Hørselsbaner



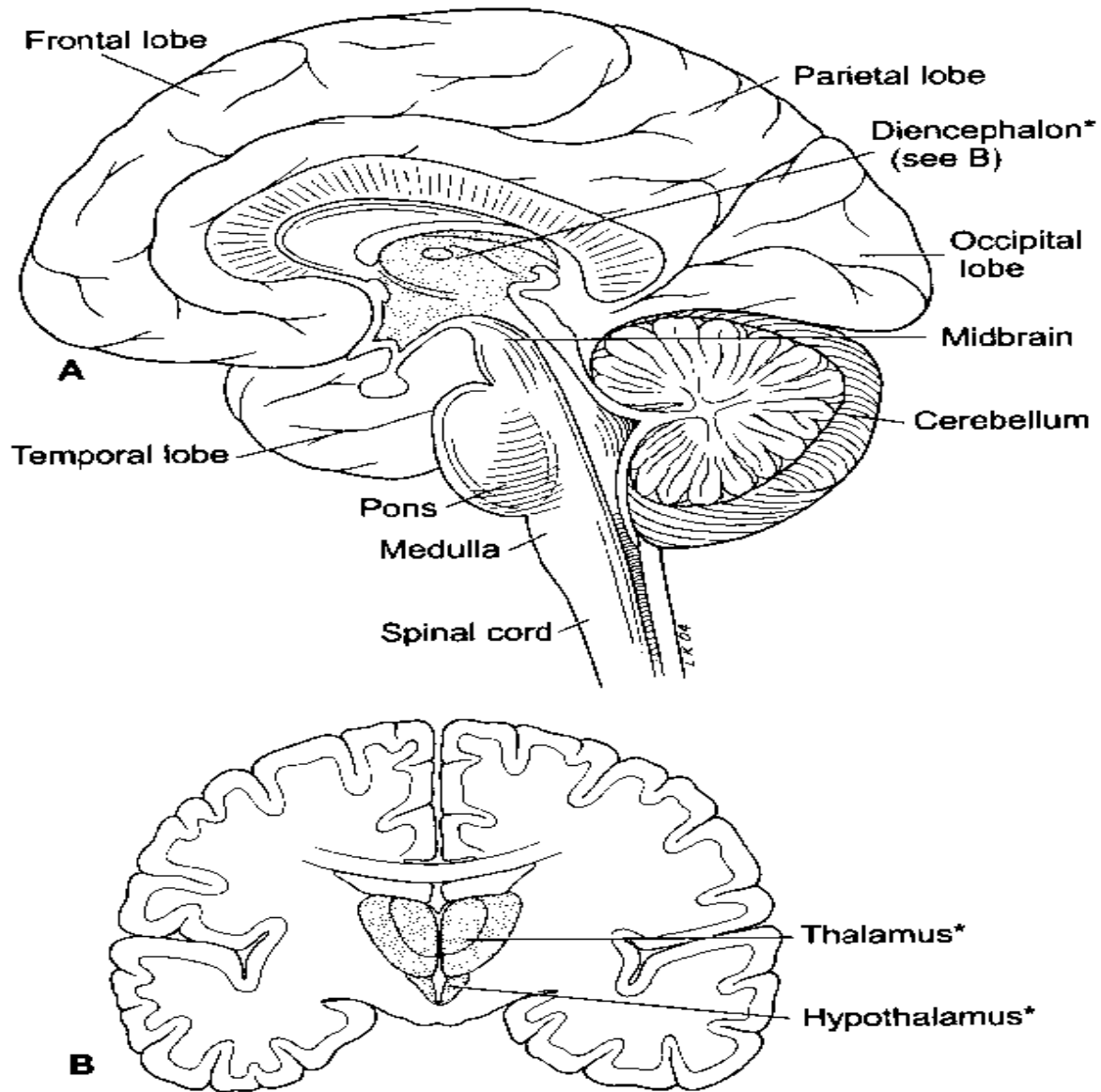


FIGURE 1–3. Major structures of the brain. **A.** Midsagittal view. **B.** Coronal section at level of diencephalon.

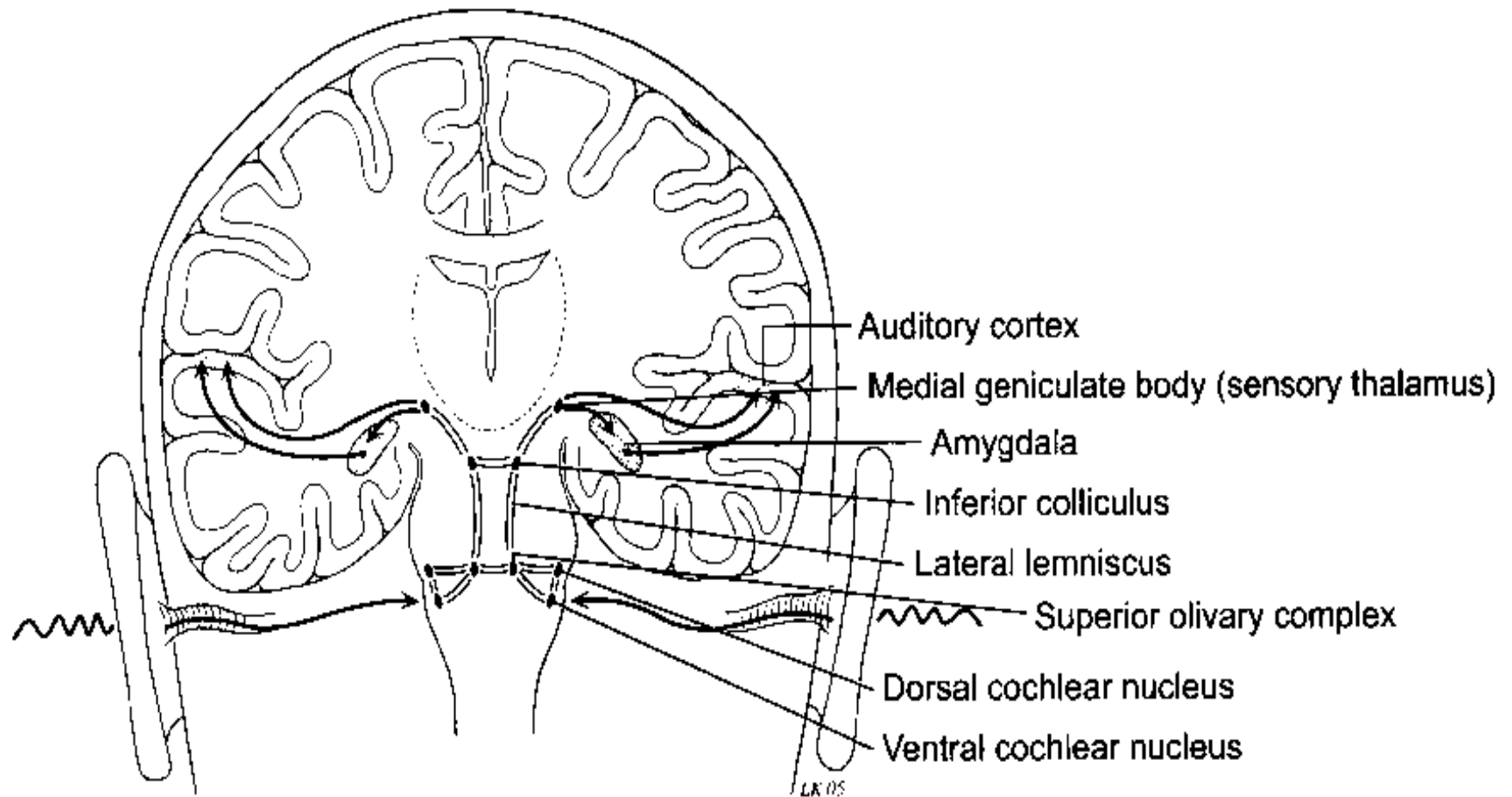
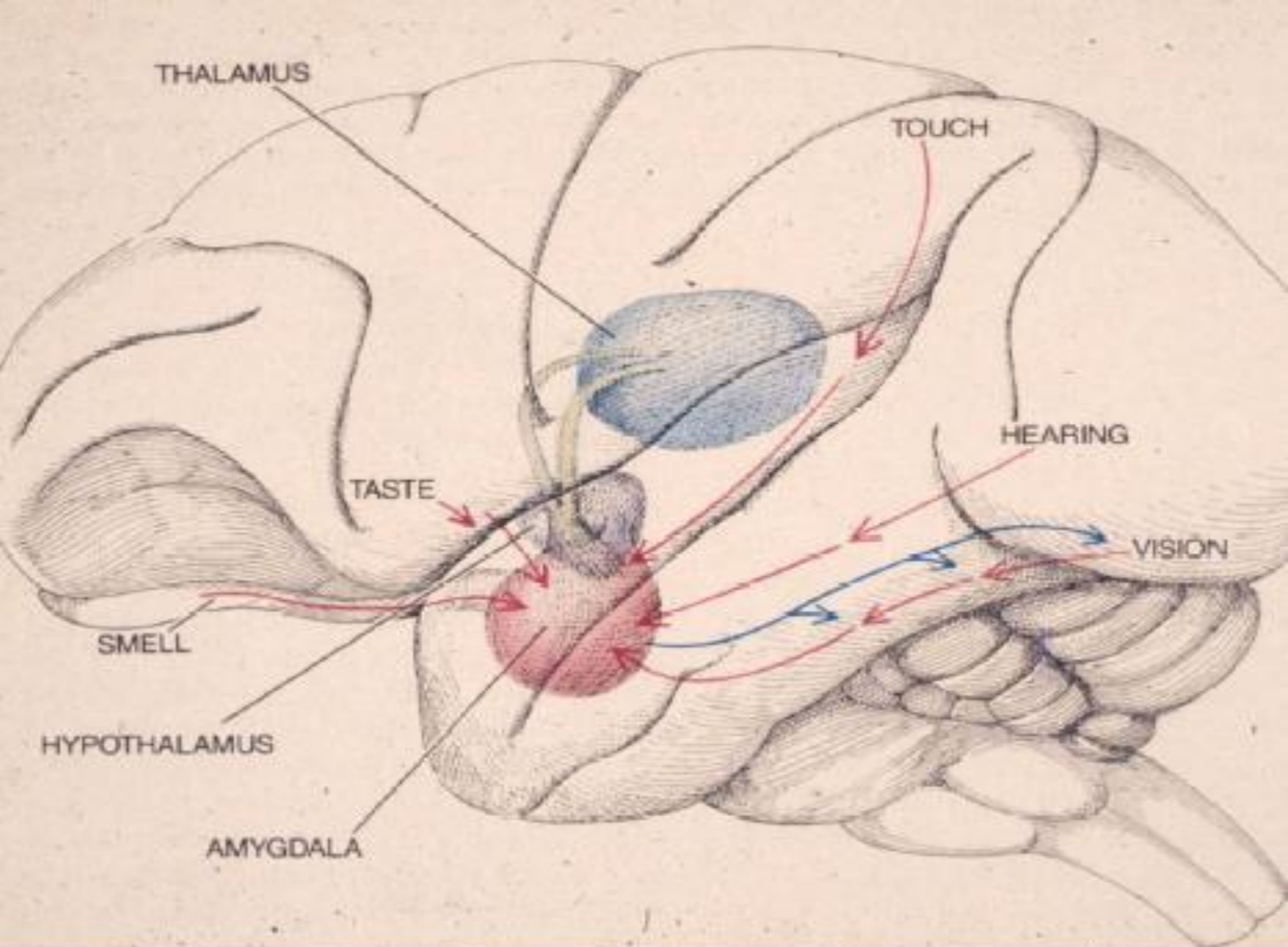


FIGURE 1-4. Central auditory pathways.



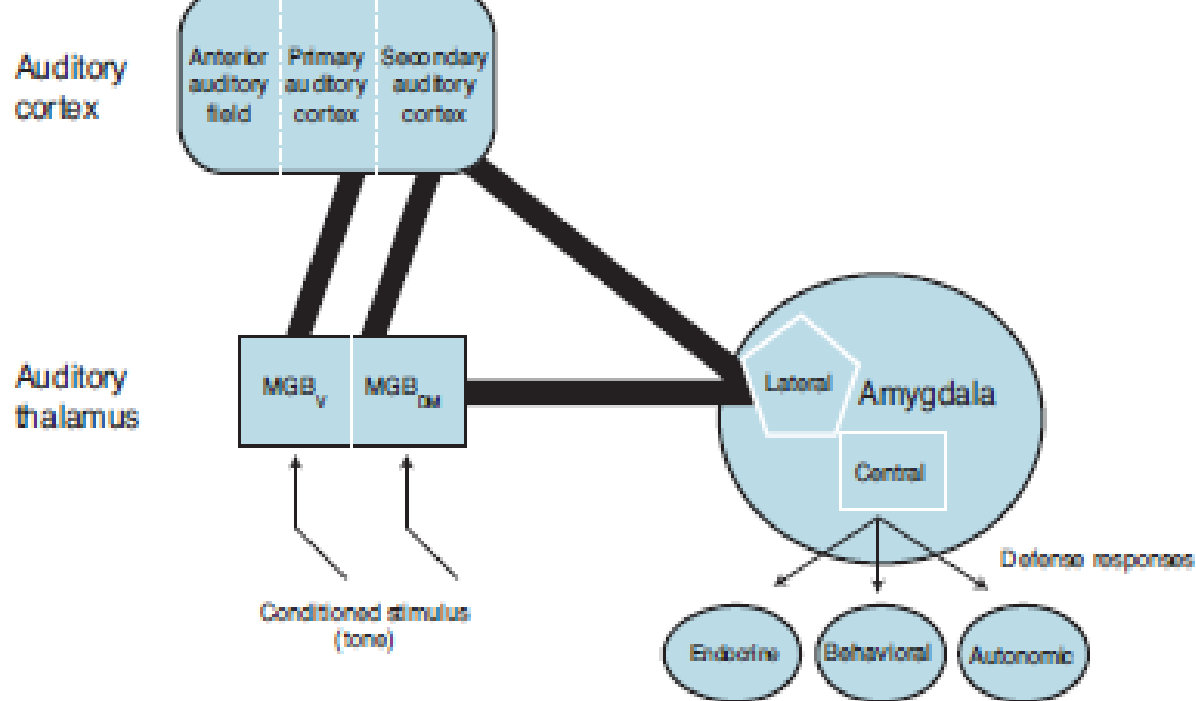
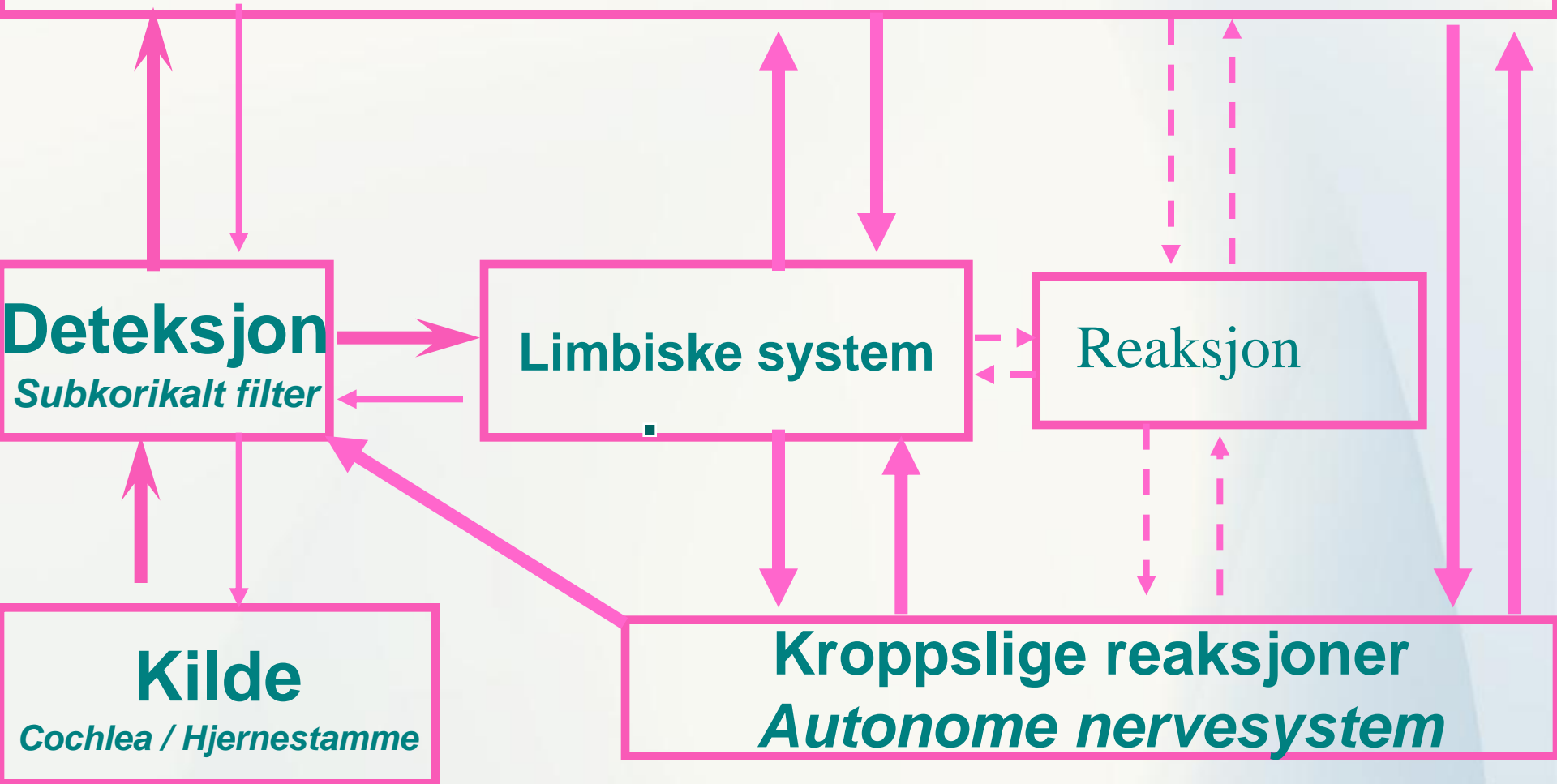


FIGURE 12-1. Schematic block diagram of the neural pathways involved in fear conditioning to acoustic stimuli (see LeDoux⁴ for details). In this representation, when the conditioned stimulus is an audible tone, the lateral nucleus of the amygdala is activated by projections from auditory processing areas in the dorsal medial aspect of the medial geniculate body and from the auditory cortex. The lateral nucleus also projects to the central nucleus of the amygdala, which controls the expression of fear through changes in behavior, endocrine function, and/or autonomic responses. Other highly relevant information concerning lemniscal and extralemniscal pathways to the amygdala is described elsewhere (see Møller¹⁶ for details). MGB_{DM} = dorsal medial division of the medial geniculate body; MGB_V = ventral division of the medial geniculate body.

Persepsjon & vurdering

Hørsel og andre kortikale områder



Måling og vurdering: PET og relaterte metoder

Aktivering av sekundære hørselcortex hos en tinnituspasient. Bildet viser forskjellen mellom hvilestilstand og etter at Xylocain er blitt administrert. Aktivering skjer på den samme side som tinnitus oppfattes



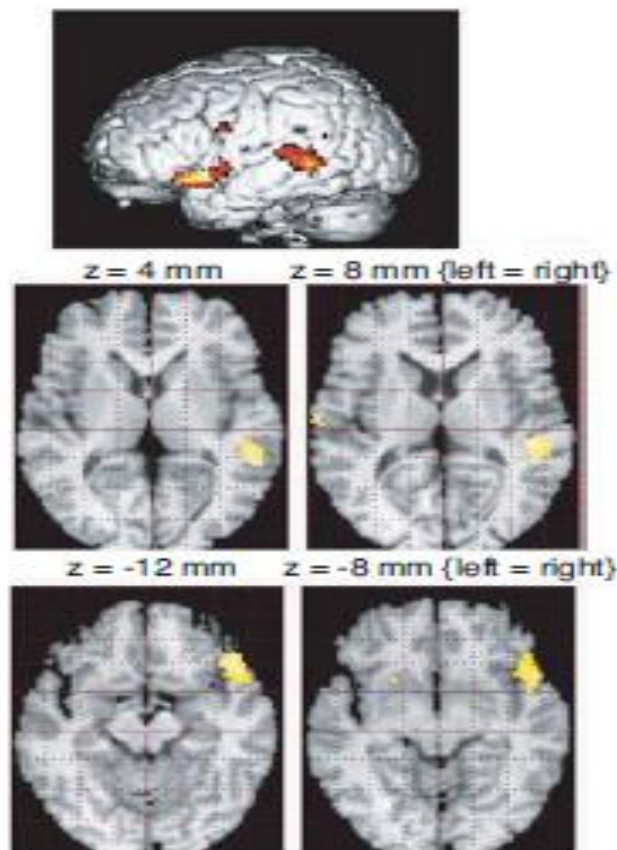


FIGURE 18-5. Expansion of neural sites activated by tonal stimuli delivered to the right ear in patients with subjective tinnitus reported in the right ear and sensorineural hearing loss. The data in this image set were produced by subtracting the sites activated by 2 kHz tones in normal controls from sites activated by the same stimulus delivered in an identical manner to the patients. Sites of additional activation in the patients are seen in the anterior portion of the superior temporal gyrus and a second site posterior and inferior to the primary auditory cortex. See Lockwood and colleagues⁷ for additional details.

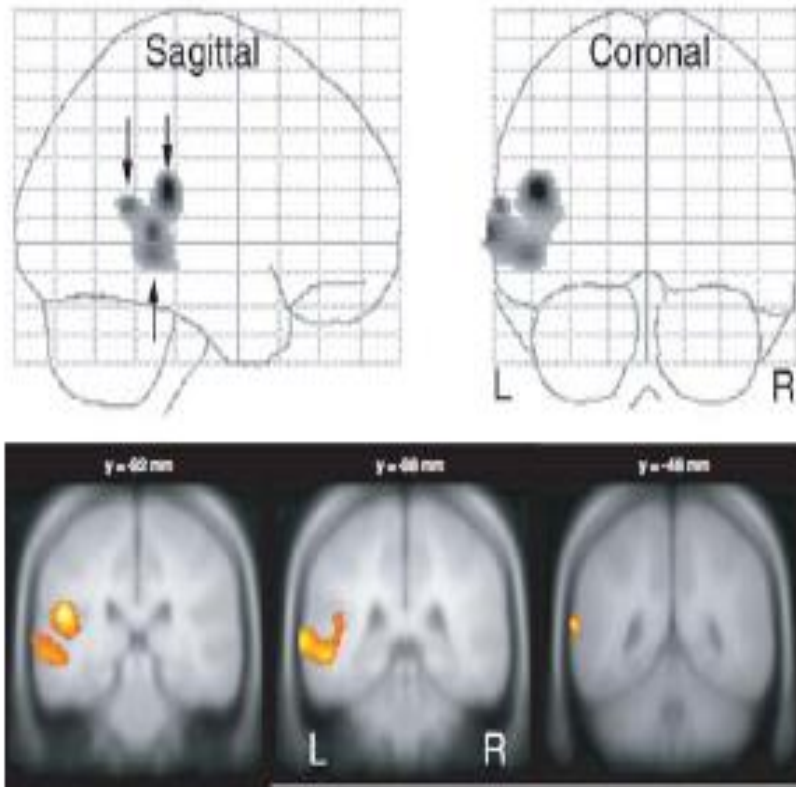
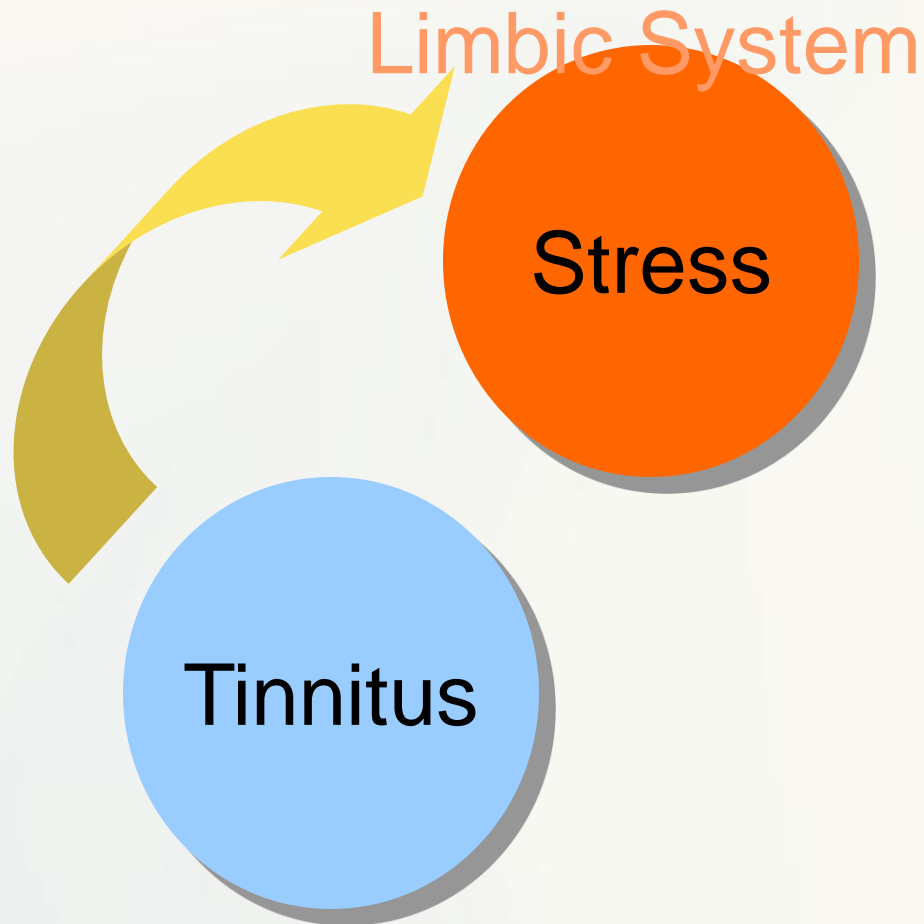
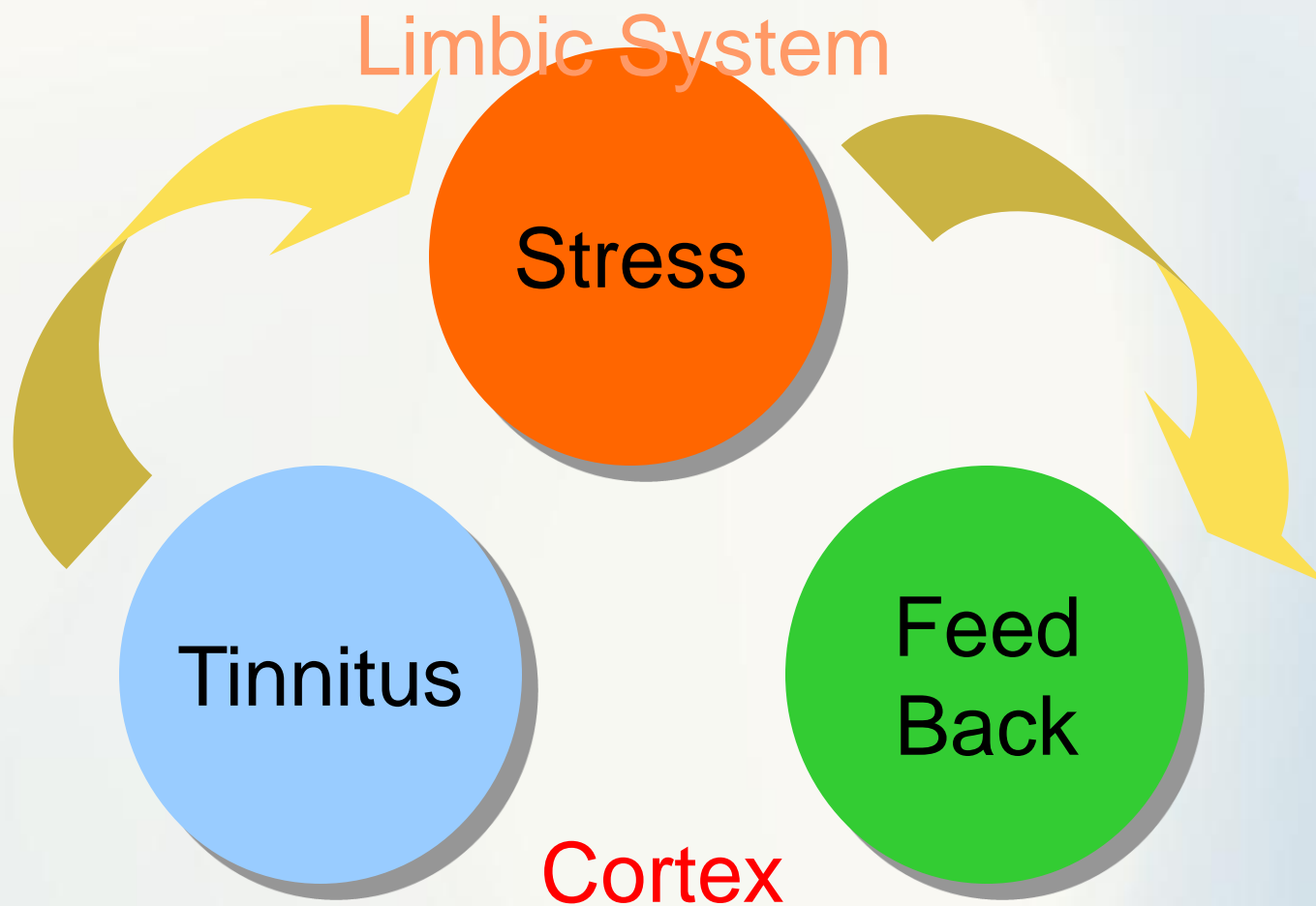


FIGURE 18-7. Sites of neural activity associated with tinnitus. Positron emission tomographic images of patient with tinnitus altered by jaw clenches were obtained. Tinnitus-soft images were subtracted from tinnitus-lou images as described in Lockwood and colleagues.⁷ The sagittal and coronal statistical parametric maps were produced as described in Figure 18-6. The *arrows* shown on the sagittal projection identify the plane of the coronal plane images shown in the lower panel, where *y* distance in millimeters are referenced to the anterior commissure plane. Reproduced with permission from Massachusetts Medical Society, Lockwood AH et al.¹

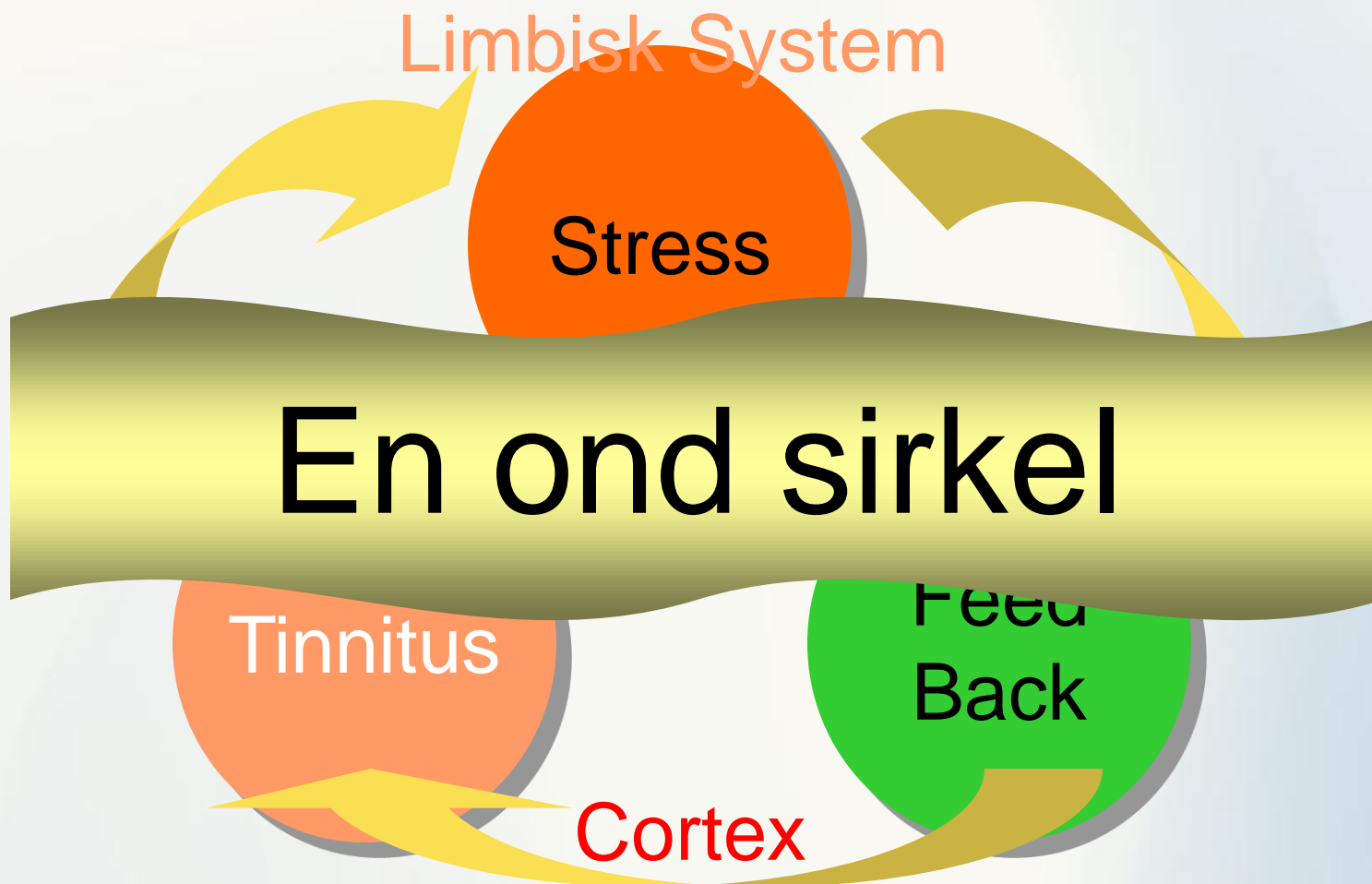
Tinnitus: A Feedback Loop



Tinnitus: A Feedback Loop



Tinnitus: A Feedback Loop



Persepsjon & vurdering

Hørsel og andre kortikale områder

H_p

Deteksjon
Subkortikalt filter

Limbiske system

H_{ER}

Reaksjon

H_{AR}

Kilde

Cochlea / Hjernestamme

Kroppslige reaksjoner
Autonome nervesystem

Grunnlag for lydbehandling

- Nervefibrene i det auditive systemet fyrer spontant selv om det ikke er noen lyd
- Bærbar lydgenerator gir en svak "tilfeldig" lyd direkte inn i øret
- Dette "presser" hørselsnervefibrene til fyre med en høyere hastighet enn de ville ha gjort i stille omgivelser.
- Dette reduserer kontrasten mellom tinnitus og bakgrunnsaktiviteten og tinnitusen ligner mer på de tilfeldige signalene som omgir den og dette fører til at tinnitusen blir mindre detekterbar

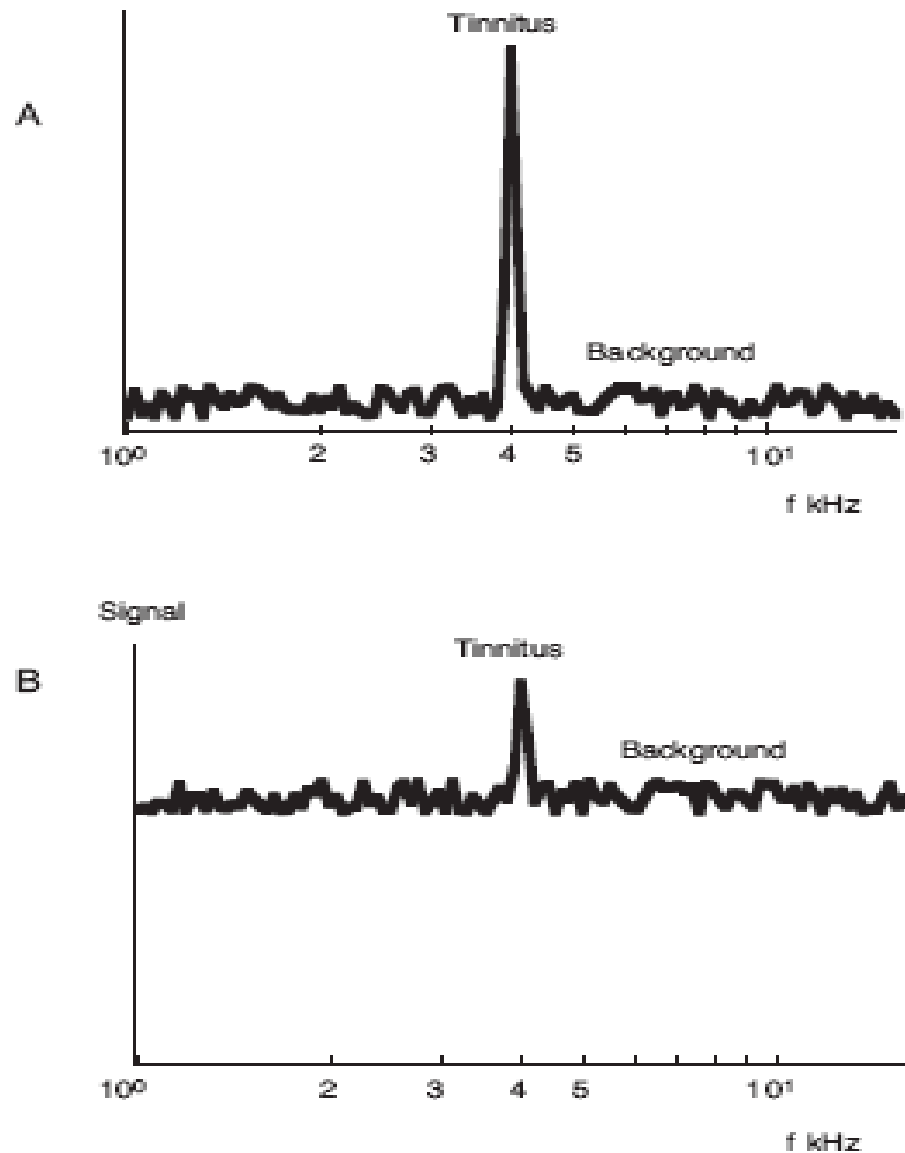


FIGURE 21-2. The strength of a signal depends on its difference from activity evoked by background sound. *A*, Tinnitus signal in silence; *B*, tinnitus with enriched background sound.



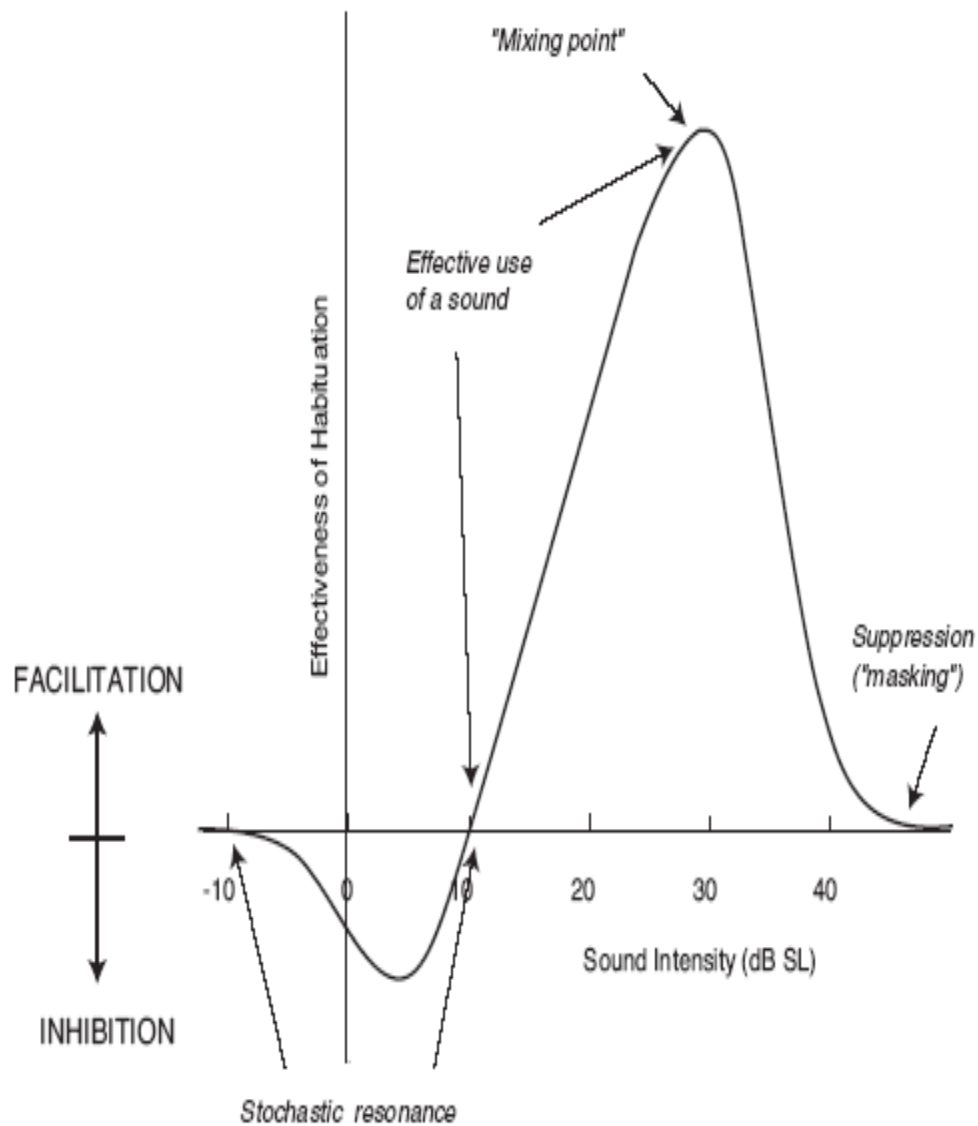
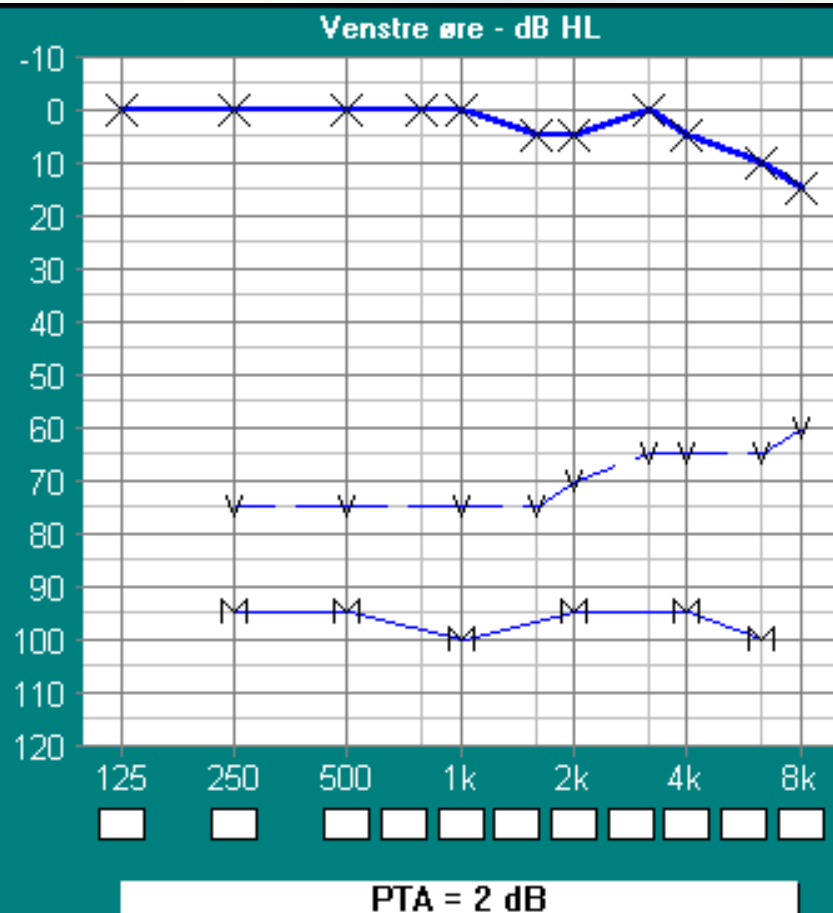
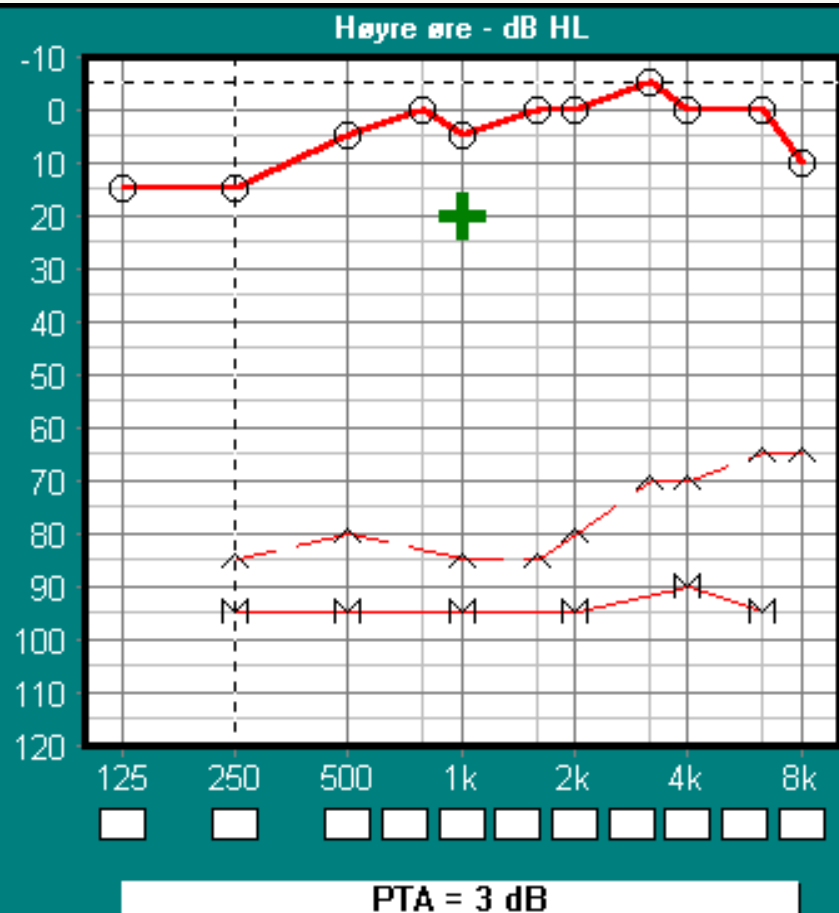


FIGURE 21-3. The effectiveness of habituation depends on sound intensity. Republished with permission from Jastreboff PJ and Jastreboff MM.⁴

Pasients LDL etter behandling



Test

- Terskel
- MCL
- UCL

Frekvens

1000 Hz

← →

Stimulus nivå

↑ ↓ 20 dB

Masking

Maskert Lås

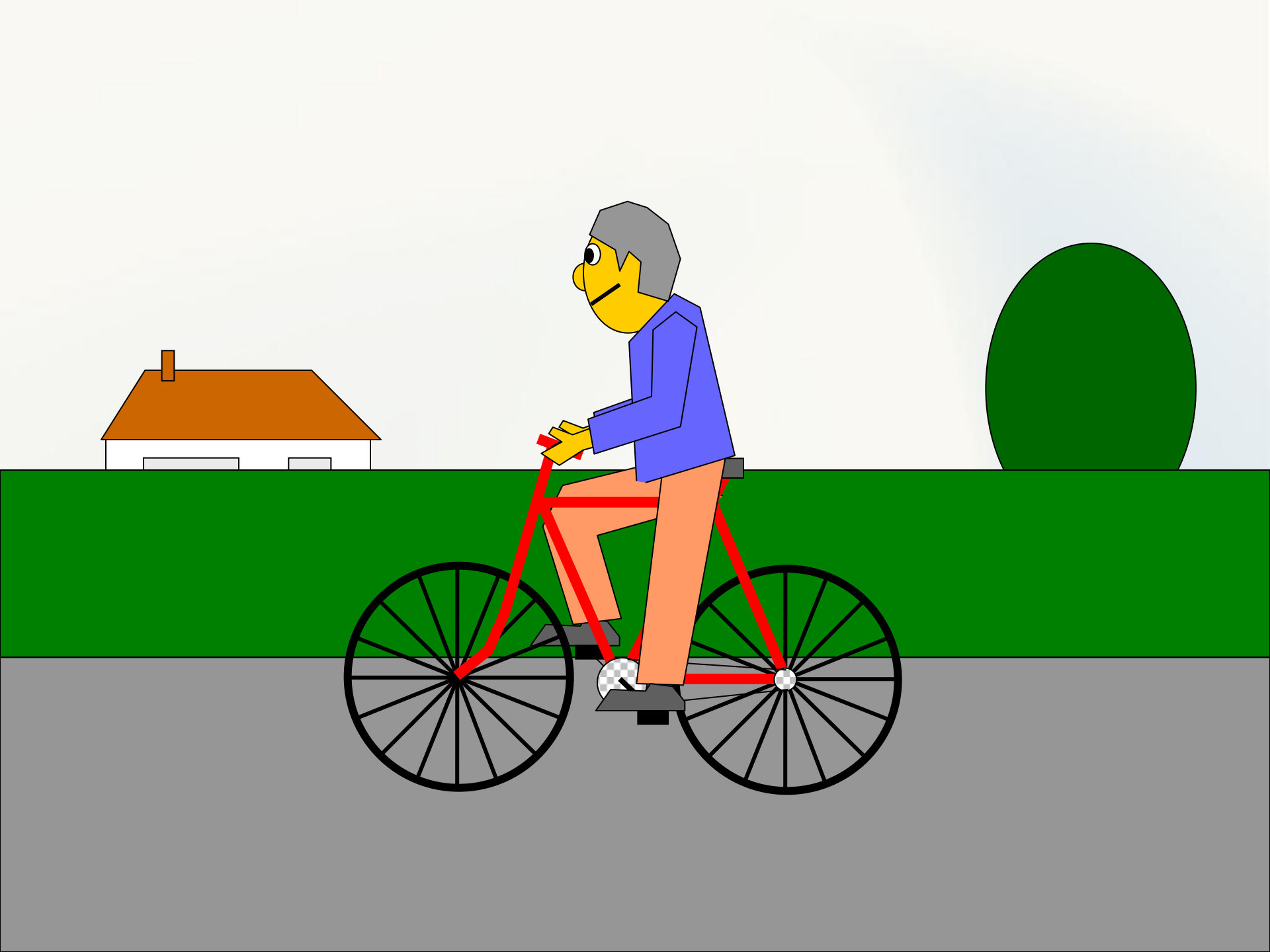
Pg Up Pg Dn 20 dB

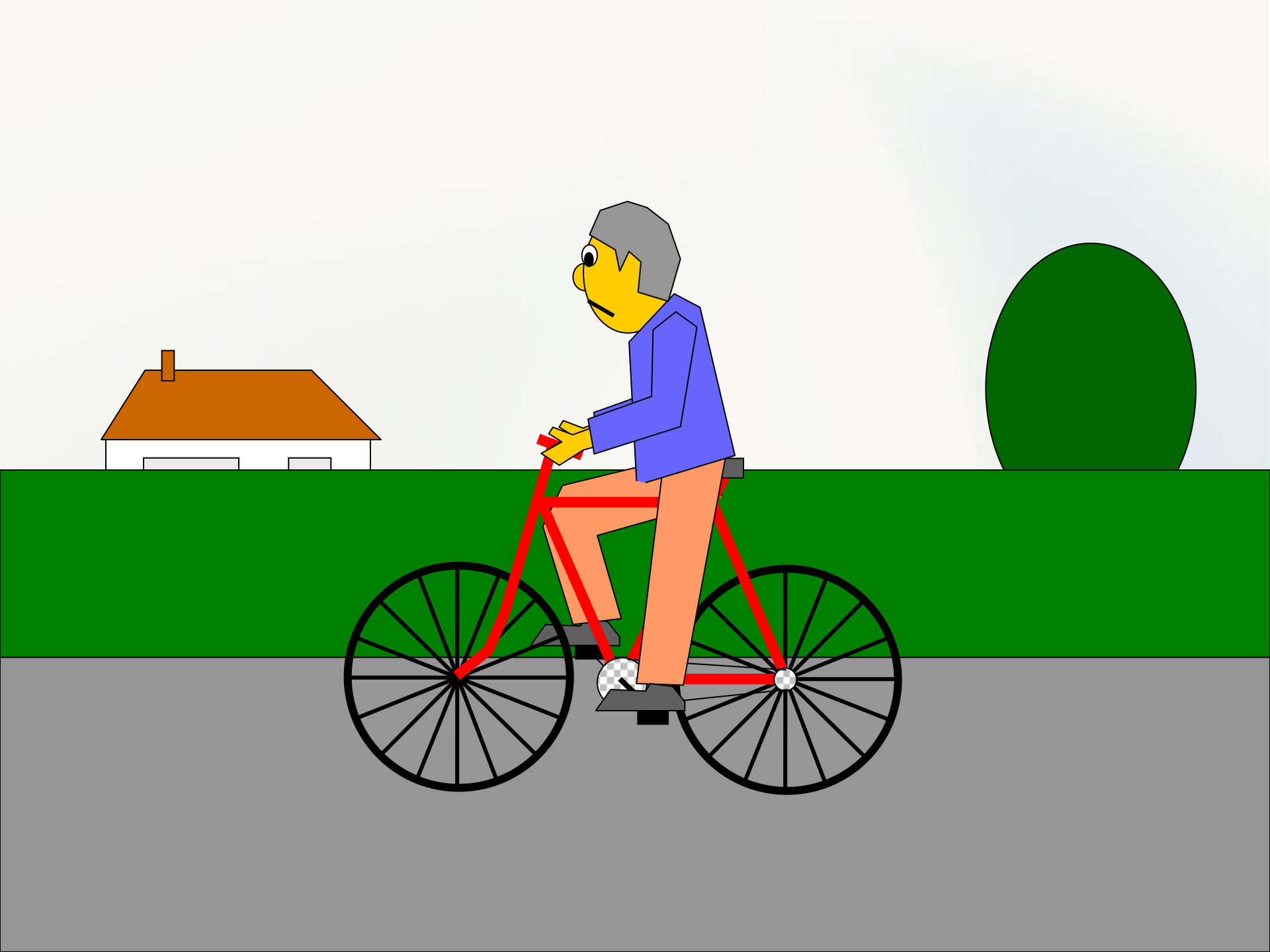
VERDENS ENKLESTE HØRSELSTEST!



- 1: hold esken
50 cm fra øret
- 2: rist godt

Hører du ikke dette?
På tide med et høreapparat?







Det var alt.....