

# Hearing Loss in the Elderly

## Hearing loss and Longevity F14

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# Hearing loss:

## Top 15 leading causes of burden of disease by 2030

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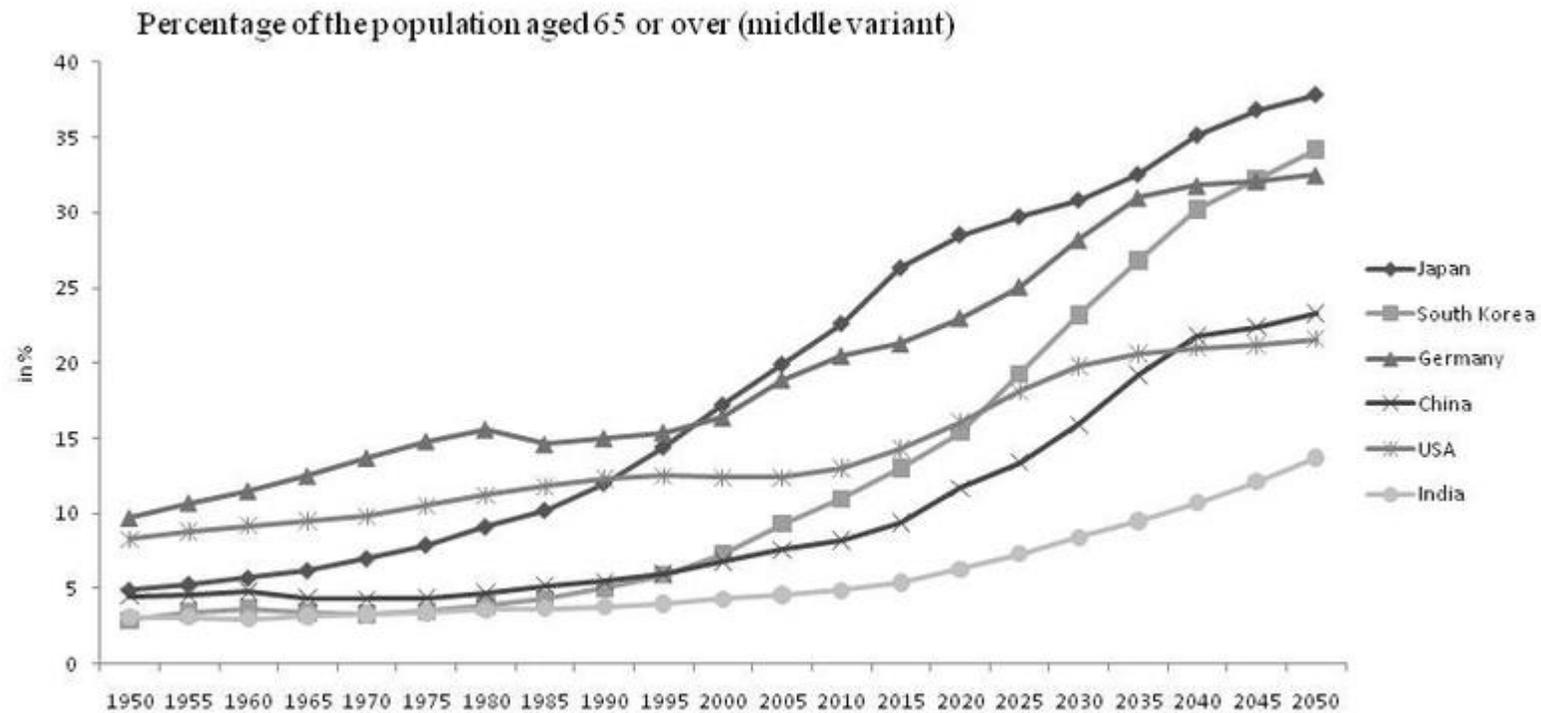
**WHY?**

Definition  
Prevalence  
Impact  
Solutions

# World Health Organization 2018 (Key findings)

- There are currently around 466 million people with disabling hearing loss globally
- There will be 630 million people living with disabling hearing loss by the year 2030
- Over 900 million by 2050

# World aging 1950-2050



Source: UN Population Division DESA, World Population Prospects – The 2008 Revision Population Database, 2009

## Countries with the highest shares of 60+ population (%) 2011-2050 (UN 2011)

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### 2011

Japan 31  
**Italy 27**  
Germany 26  
Finland 25  
Sweden 25  
Bulgaria 25  
Greece 25  
Portugal 24  
Belgium 24  
Croatia 24

### 2050

Japan 42  
Portugal 40  
Bosnia and Herzegovina 40  
Cuba 39  
Republic of Korea 39  
**Italy 38**  
Spain 38  
Singapore 38  
Germany 38  
Switzerland 37

# European federation of 'Hard of Hearing' people 2015

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- Approximately one third of people over 65 years of age are affected by disabling **hearing loss** (Mar 20, 2019)

# Hearing loss in Italy

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- Age-related hearing loss and the risk of cognitive impairment and dementia in later life. 2018 (Bari; multi-centered)
  - ARHL prevalence :
    - **25–30% in aged 65–74**
    - **63.1% over 80 years**
    - **80.6% over 85 years**
  - Hearing difficulties may be not related only to the peripheral auditory system impairment but also to the **central auditory processing disorder**, problems in understanding speech in a background noise

Bari, Florence, Milan, Padua, Palerm, Quaranta A and N, 1996, 2015

# Italian Sistema Statistico Nazionale-Istituto Nazionale di Statistica (2001)

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- More men than women
- The difference in gender is greater among the elderly (65 to 74 years of age and  $\geq 75$  years of age).
- the highest population of Italians who have hearing loss live in the Nord-Oriental region of Italy (19 per thousand) and the Central region of Italy (17.7 per thousand):
  - Umbria (24.2 per thousand)
  - Emilia Romagna (21.9 per thousand)
  - Tuscany (21 per thousand)
  - Friuli Venezia Giulia (21 per thousand).

# Hearing loss in Israel

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- A recent study estimated that over 800,000 people in Israel have some hearing loss
- Non-even distribution
- The annual (average) growth of the population is ~1.6%
  - People >65Y = 11% (2015), 14.3% (2040), 15.3% (2060)

# Levels of 'noise' in life

**Moderate— Safe** listening for any time period

**70 dBA = group conversation**, vacuum cleaner,

**60 dBA = typical conversation**, dishwasher,  
clothes dryer

50 dBA = moderate rainfall

40 dBA = quiet room

**Very loud— Dangerous to hearing**

91 dBA = subway, **passing motorcycle**

**Extremely loud— Dangerous to hearing**

**112 dBA = maximum output of some MP3 players**

106 dBA = gas leaf blower

100 dBA = tractor, **listening with earphones**

94 dBA = hair dryer, kitchen blender, food processor

# Hearing impairment categories

*the better ear hearing threshold (dB)*

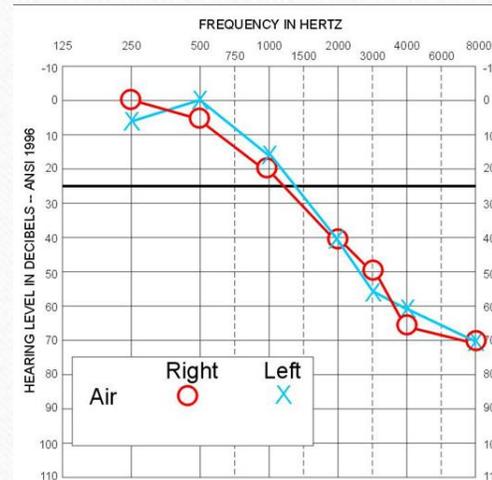
Degree of Hearing Loss	HearingLoss Range (dB HL)
Normal	-10 to 15
Slight	16 to 25
Mild	26 to 40
Moderate	41 to 55
Moderate/Severe	56 to 70
Severe	71 to 90
Profound	91+

Source: Clark, J. G. (1981). Uses and abuses of hearing loss classification. *Asha*, 23, 493-500.

impairment category	Better ear hearing level (dBHL)	Hearing in a <b>quiet</b> environment	Hearing in a <b>noisy</b> environment
<b>Mild</b>	<b>20–34</b>	Does not have problems hearing what is said	<b>May have real difficulty taking part in a conversation</b>
<b>Moderate</b>	<b>35–49</b>	May have difficulty hearing a normal voice	<b>Has difficulty hearing and taking part in conversation</b>
<b>Moderately Severe</b>	<b>50–64</b>	Can hear loud speech	<b>Has great difficulty hearing and taking part in conversation</b>
<b>Severe</b>	<b>65–79</b>	Can hear loud speech directly in one's ear	Has very great difficulty hearing and taking part in conversation
<b>Profound</b>	<b>80–94</b>	Has great difficult hearing	Cannot hear any speech

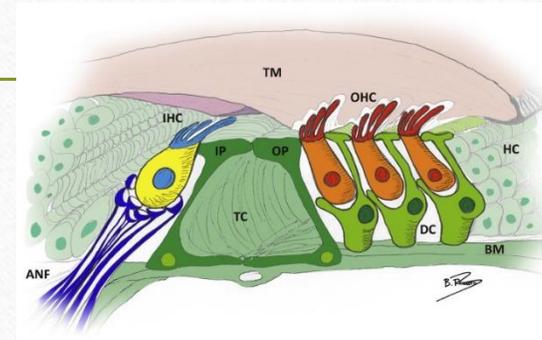
# Characteristics of hearing loss of the elderly - “Presbycusis”

- Progressive; Bilateral; Symmetrical; Sensorineural
- Most marked at higher frequencies (high-pitched sounds)
- Typically begins in the mid-age, but the sharpest rise in prevalence occurs at > 80 years (50–80% are affected)
- No cure

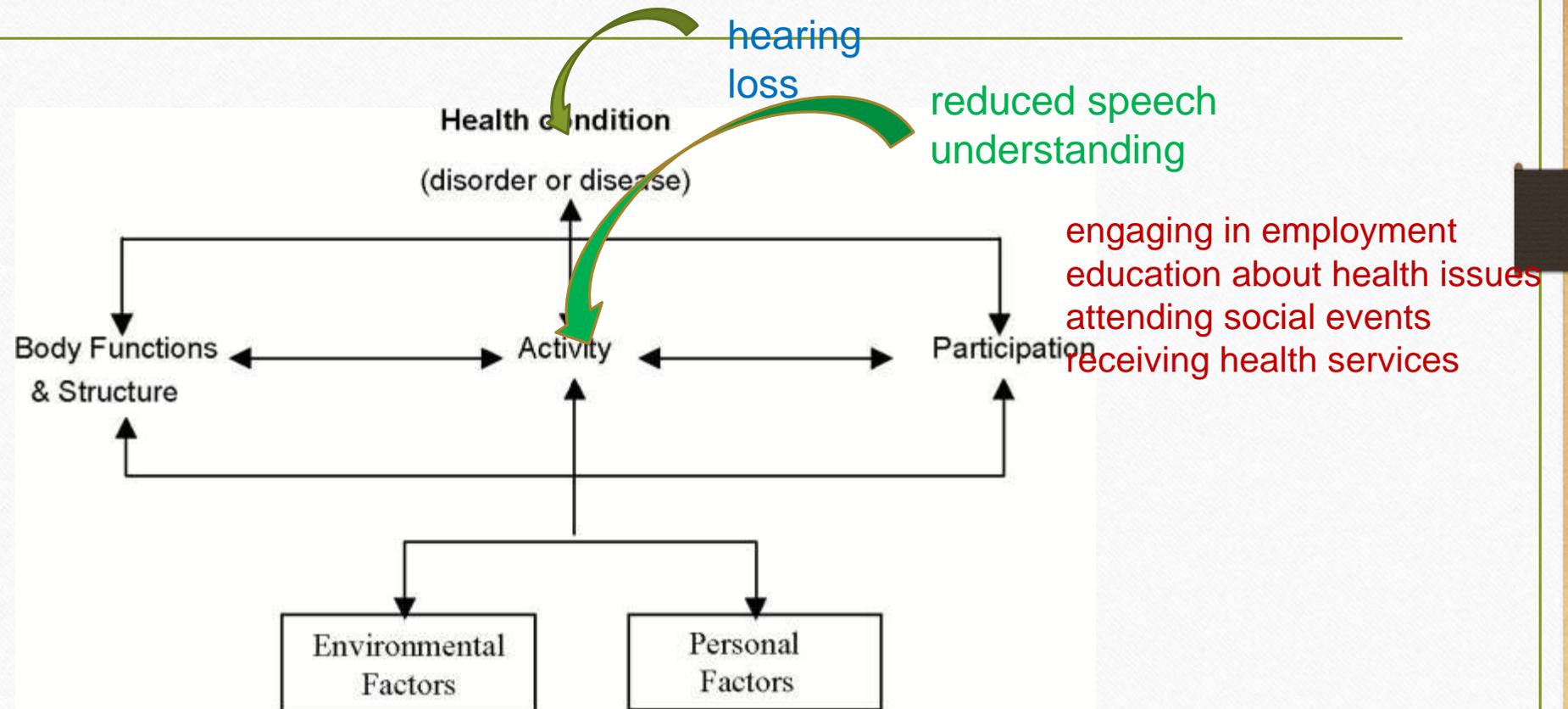


# Pathogenesis and Pathology of Presbycusis

- Genetic
- Environmental
  - multiple morbidities
- Progressive damage and loss of sensory hearing cells in the cochlea and to its vascular system
- Damage to the neurons that relay auditory information from the inner ear to the central auditory system
- Central processing of information, leading to impaired understanding



# Health condition, and its bio-psycho-social-environmental context



# The effects of hearing loss

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- Decreases social engagement
- Increases symptoms of depression
- Increase the risk of falling
- Negative impact on cognitive performance

# Economic effects of hearing loss

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The effects of hearing loss on work participation may interfere with plans to extend the retirement age

# Cognitive decline and hearing loss

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- Consensus:
  - A link between ARHL and cognitive decline, impaired performance across cognitive domains, and increased risk for dementia
- The Lancet Commission statement (2017):
  - Hearing loss = the largest **potentially modifiable risk factor** for dementia among nine health and lifestyle factors

# Hearing loss and dementia

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- Hearing impairment is independently associated with a 30%–40% rate of accelerated cognitive decline
- Individuals with a mild, moderate, and severe hearing impairment, respectively, had a X2, 3X, and 5X increased risk of incident all-cause dementia over >10 years of follow-up

# Linkage hypothesis

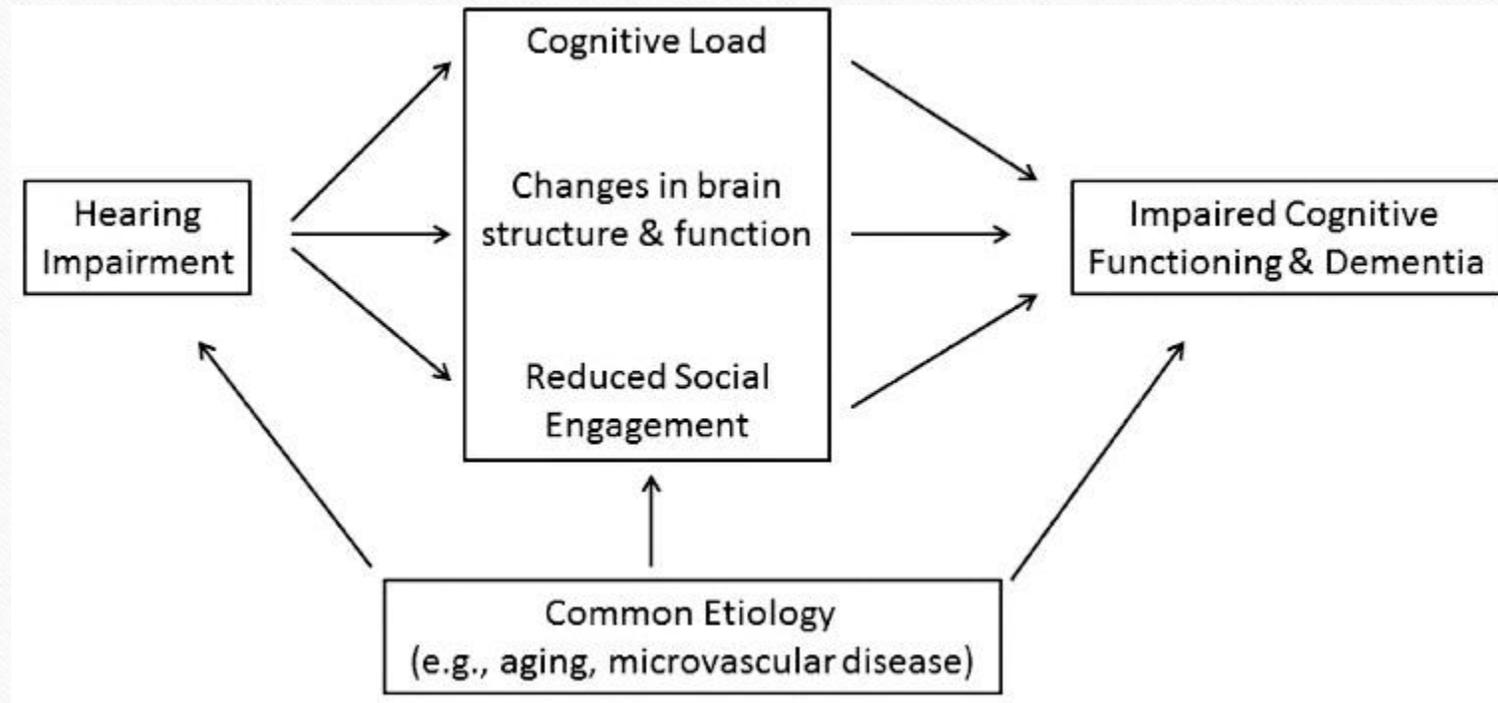
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- **Cognitive load hypothesis**

- **The cognitive capacity in working memory is limited**

- Hearing loss leads to degraded auditory signals
- Greater cognitive resources being required for auditory perceptual processing
- Diversion from other tasks to effortful listening, eventually resulting in cognitive reserve depletion

# A model of association of hearing impairment with cognitive functioning and dementia.



# Repair ?

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- Cochlear tissues have a very limited repair capacity and mature cochlear cells do not regenerate, making any cellular loss permanent
- **Rehabilitation** may be achieved by amplification (hearing aid) or implantation (by-passing the end organ hair cells)

# Hearing aids use

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- Only a minority of individuals with hearing difficulties are using hearing devices
  - 4-22% in elderly with a mild-to-moderate HL in the US
  - 14-27% in mild HL (of all ages) in Germany, France, and UK

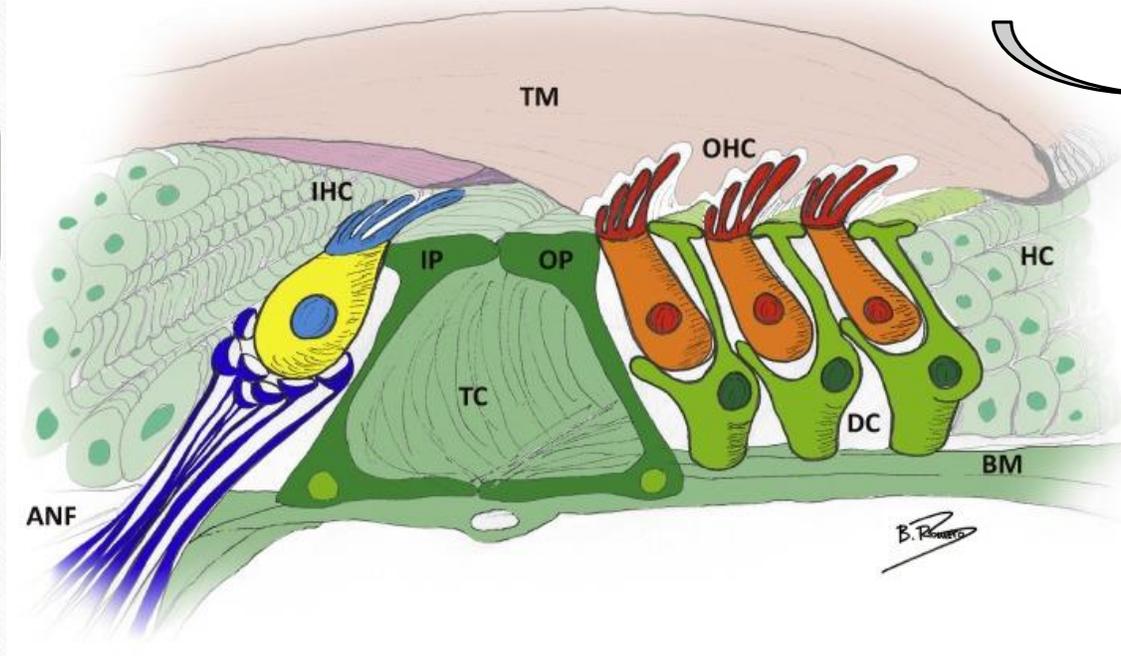
# Hearing aids (not) use *(Trends Hearing 2018)*

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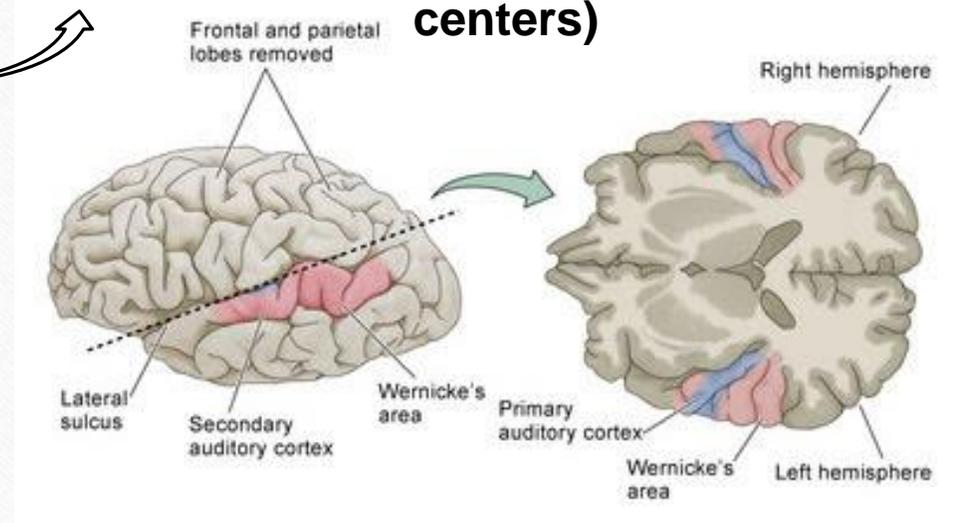
- Unawareness - gradual onset of age-related hearing loss
- Stigma (by gender)
- 'Locus of control', faith in the ability to personally control what happens to oneself
- Severity of HL
- Technology control
- Socio-economic status

# Structural basis of cochlear function and system

Hair cells = mechano-electrical transducers



Auditory cortex (primary and secondary centers)



Courtesy of Bárbara Romero and Francisco Carricondo. Department of Ophtalmology and Otorhinolaryngology. University Complutense of Madrid (Spain).

# Cochlear hair cells regeneration

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- **In birds**, complete regeneration was observed in 10 days, following acute phonal trauma
  - It is currently thought that, in birds, hair cell renewal can occur and that there is a regenerative capacity

# Cochlear hair cells regeneration

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- **In mammals**, however...
- Only a few adult tissues, i.e. skin, blood or placenta showed the ability to regenerate
- The current consensus is that **inner ear hair cells do not regenerate**

# In a chinchilla model

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- Following aminoglycosides administration...
  - There was a clear recovery of the epithelium while the percentage of supporting cells was maintained close to normal

# Recent advances in regeneration of cochlear HC and auditory neurons

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- 3 pass-ways:
  - Survival factors to protect non-damaged cells
  - Regeneration with endogenous cells
  - Regeneration with exogenous cells

# Survival factors of protection

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- A **therapeutic window** between HC insult and neuronal injury
- Antioxidants (i.e. melatonin, resveratrol, DHA-docosahexaenoic acid) can exert neuro-protective effect

# Possible ways of regeneration

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- Endogenous cells
- Exogenous cells; cell therapy
- Fibroblast trans differentiation
- Adult stem cells

# Regeneration with endogenous cells

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- Retinoblastoma 1 (RB1)
  - an endogenous protein
  - plays an essential role in regulating cellular proliferation and differentiation

# Fibroblast transdifferentiation

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- There are transcription factors involved in adult fibroblast reprogramming into a cell phenotype which can be differentiated into a variety of cell types
- Transplantation of neural stem cells could be useful for preventing the damage to hair cells that occurs after transient ischemia of the cochlea ?

# Adult stem cells

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- Exist in nearly every tissue
- Ethically accepted:
  - no tumors, very low immunoreactivity

# In conclusion

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- Hearing loss in the elderly = “presbycusis” is a very common disorder
  - Expressed by difficulties in hearing and understanding
  - A critical effect upon social and cognitive achievements
- Hearing improvement delays Dementia
- Hearing improvement is a key factor in quality of life among older-aged people

# Message

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- Bringing together health specialists of all domains will better address hearing loss in the context of brain and cognitive aging and quality of life improvement
- We all need to be involved in -
  - Accepting hearing aids as “ear glasses”
  - Encouraging ‘hard of hearing’ to be involved in society
  - Maintain accessibility in all circumstances

Thank you

Toda  
raba

Grazie mille