Multidisciplinary approach to tinnitus

IFOS VIETNAM course

Marie Jose Fraysse MD , ENT and
PARIS CEFON and Clinique de l'oreille

Pathophysiology of tinnitus

- **Based on the concept :**

Tinnitus is linked to deafness

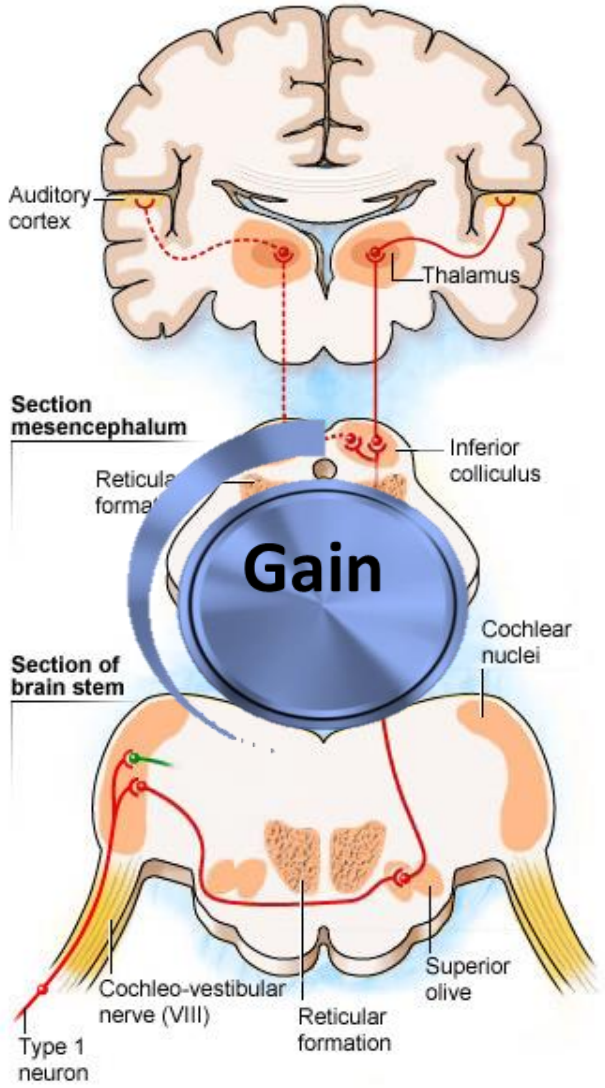
It results from the perception of abnormal neural activity in the auditory central nervous system (CNS), such as a reduction in the neural input expected from a healthy ear. (homeostatic balance)

- How do we explain tinnitus after sound trauma? with a normal audiogram?
- Somato sensory tinnitus?

Mechanisms of tinnitus:

- 3 categories of mechanisms of tinnitus with **deafness:**
  - deafferentation with maladaptive compensatory response.
  - increased spontaneous activity of central auditory neurons .
  - increased cross-fibers connections.

- **Hyperactivity** of the auditory pathways from the cochlear nucleus to the auditory cortex



Eggermont JJ and Komiya H. Moderate noise trauma in juvenile cats results in profound cortical topographic map changes in adulthood. *Hear Res* 2000; 142: 89–101.

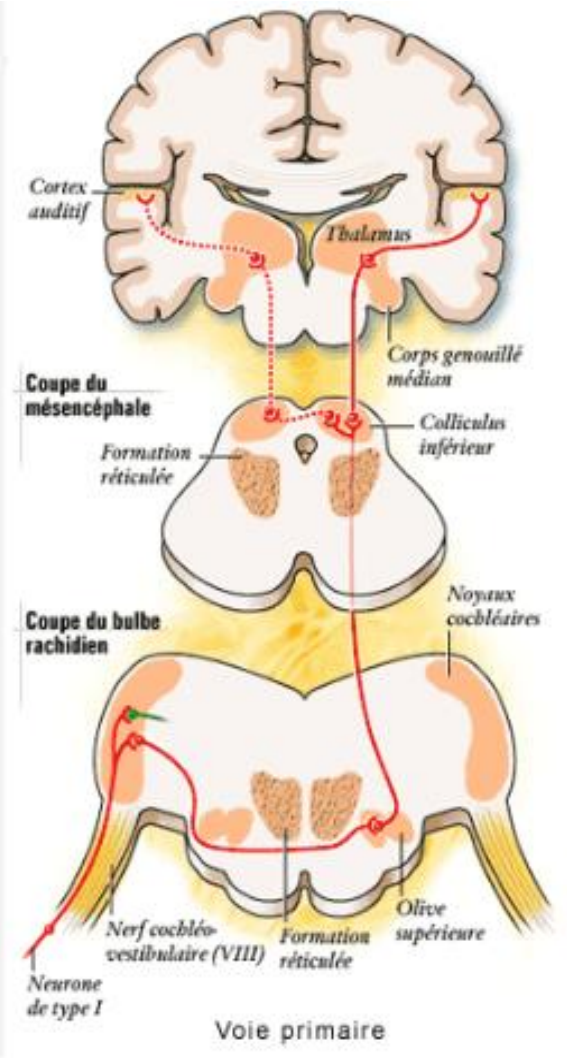
Eggermont JJ and Roberts LE. The neuroscience of tinnitus: understanding abnormal and normal auditory perception. *Front Syst Neurosci* 2012; 6: 53.

De Ridder D, Elgoyhen AB, Romo R, *et al.* Phantom percepts: tinnitus and pain as persisting aversive memory networks. *Proc Natl Acad Sci U S A* 2011; 108: 8075–8080.

Sound trauma (only inner ear problem ?)

- **Sound trauma (ST)** induces plastic changes in the neural activities of the auditory pathways, with an increase of spontaneous activity (Eggermont 2017, Salvi 2010).
- By modifying the balance between the activation and inhibition systems of neural circuits (Eggermont 2017,Caspary et al 2017,Auerbach 2014)

- Sound trauma **alters synaptic inhibition** in the dorsal cochlear nucleus (DCN), inferior colliculus (IC), medial geniculate body (MGB) and auditory cortex.
- **The balance between excitation and inhibition is disturbed**
- By what process? Possible cause of tinnitus ?



Acoustic trauma induced the alteration of the activity balance of excitatory and inhibitory neurons in the inferior colliculus of mice

Hearing Research 391 (2020) 107957

Lanlan Ma [a, b, 1], Munenori Ono [b, *, 1], Ling Qin [a], Nobuo Kato [b]

[a] Department of Physiology, China Medical University, Shenyang, 110122, China
[b] Department of Physiology, Kanazawa Medical University, Ishikawa, 920-0293, Japan

The IC is made up of excitatory glutamatergic neurons (75%) and inhibitory GABAergic neurons (25%).

Study: 48 transgenic mice; **ST 1 h at 116 dB**, right ear ;

1) ABR threshold analysis (8 to 32 kH frequencies) before and after D1 and D 2 months.
2) Single-cell recording in the left IC (craniotomy and cement pillar) 30 s
3) Light signals to identify cell type (Gaba or glutamatergic)
4) Analysis of spontaneous activity , number of spikes , ½ width of spikes etc....

Acoustic trauma induced the alteration of the activity balance of excitatory and inhibitory neurons in the inferior colliculus of mice

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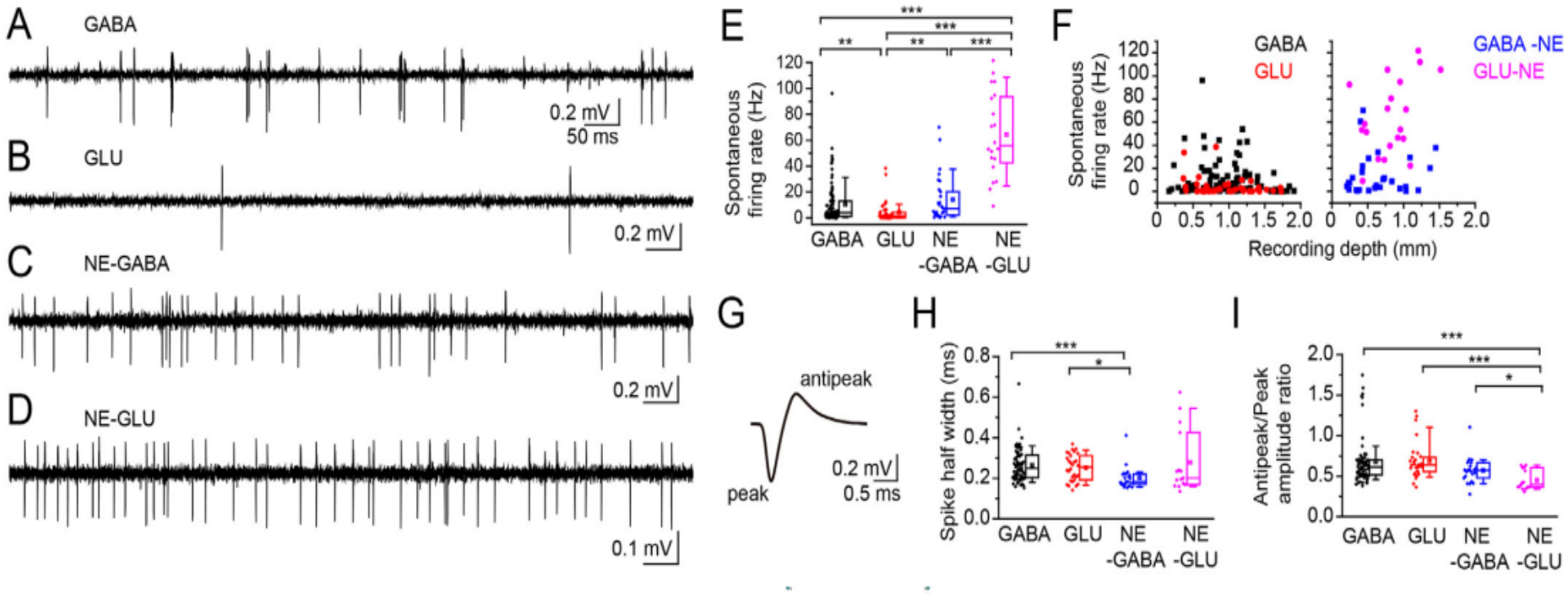
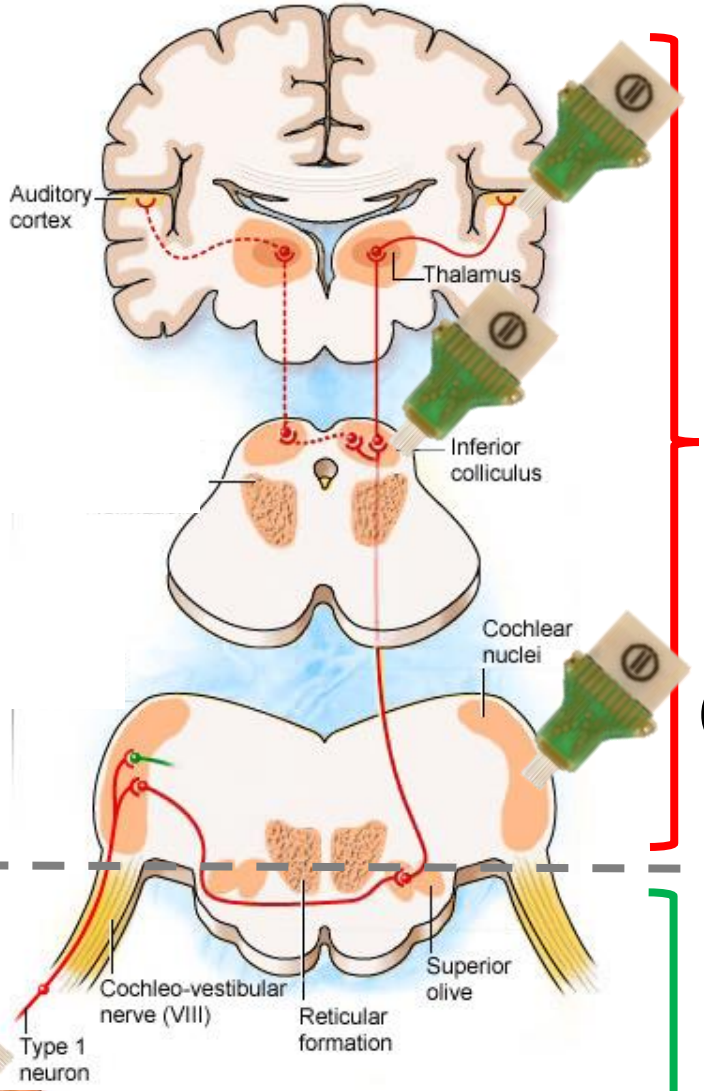


Summary

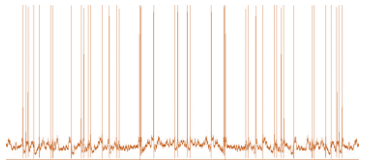
Arnaud Norena courtesy



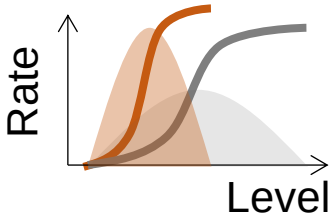
Neural hyperactivity

Stimulus-evoked activity: **hyperacusis?**

Spontaneous activity: **tinnitus?**

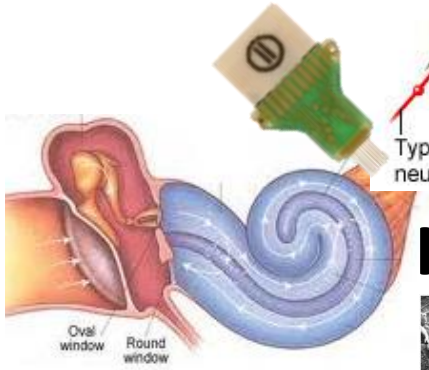


Input-output function

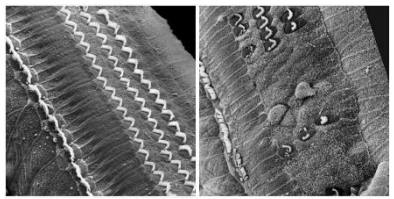


Centers: Processing stage

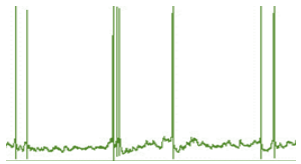
Noise trauma



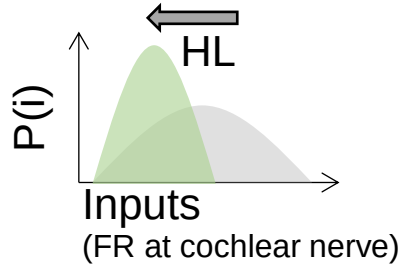
Hearing loss



Neural hypoactivity



Input distribution

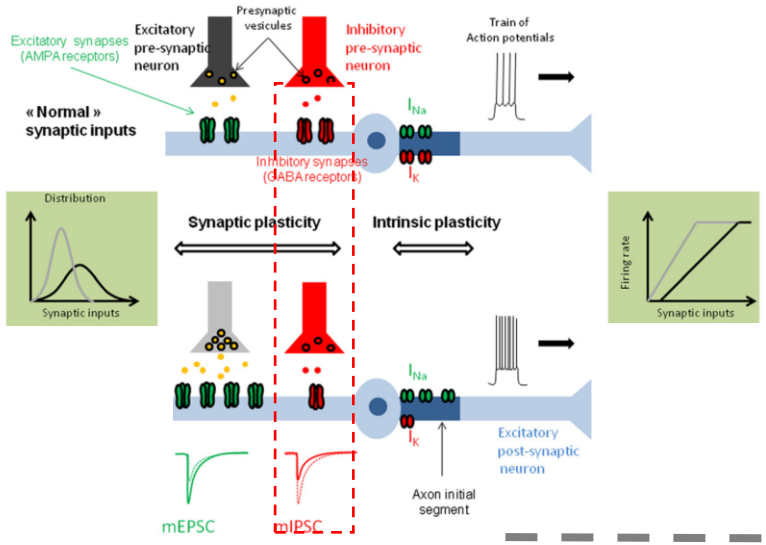


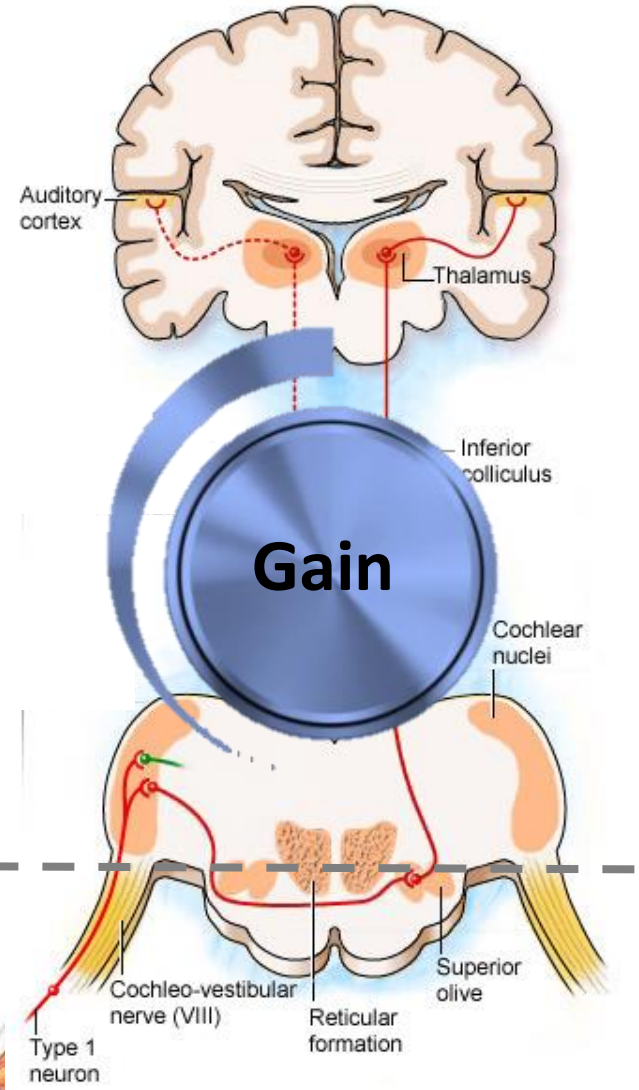
Periphery: "Input" stage

Homeostatic Plasticity

➔Averaged neural activity is constant

➔Large repertoire of mechanisms





Neural hyperactivity

Stimulus-evoked activity: hyperacusis?

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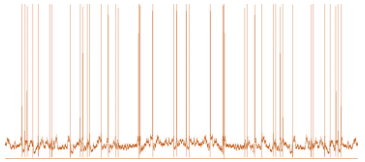
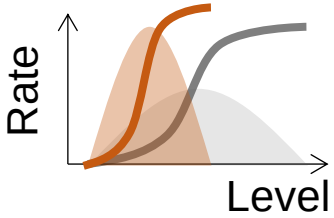
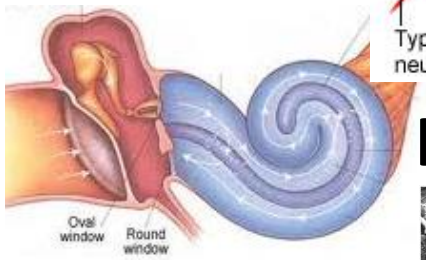


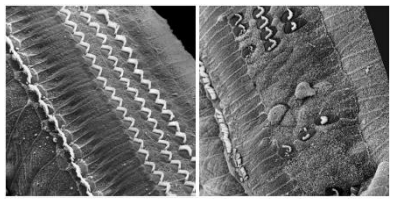
Input-output function



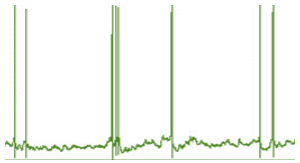
Noise trauma



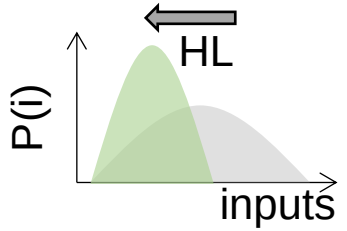
Hearing loss



Neural hypoactivity



Input distribution



Homeostatic Plasticity

- **It has been suggested that neural hyperactivity in the auditory centers after hearing loss may be related to homeostatic plasticity.**

- Homeostasis is a regulatory process by which the body maintains the constants of the internal environment within the limits of normal values.
- It is an ecosystem that resists possible variations and maintains a state of equilibrium.(e.g. temperature, blood sugar level or stress…)

The role of neuroinflammation

Journal of Clinical medecine 2022

The Role of Inflammation in Tinnitus: A Systematic Review and Meta-Analysis

Lilian M. Mennink [1,2,3,*] , MarlienW. Aalbers [1,3], Pim van Dijk [2,3] and J. Marc C. van Dijk

Current Otorhinolaryngology Reports (2022) 10:322–328
https://doi.org/10.1007/s40136-022-00411-8

Neuroinflammation in Tinnitus

Katherine Adcock[1,2] · Sven Vanneste[1,2]

- Recent work suggests that neuroinflammation plays a role in the development of acute tinnitus and in its chronicisation.

- The disorders associated with hearing loss and or sound trauma generate an NI response which causes a feedback loop between the cytokine (TNF alpha) and the activation of the microglia.

- persistent inflammation- induced changes in inhibitory and excitatory functions lead to hyper-excitability of the auditory system and potentially to the development of tinnitus

- Analogy with pain

Journal of the Association for Research in Otolaryngology
https://doi.org/10.1007/s10162-023-00914-1

JARO

REVIEW

Review and Perspective on Brain Bases of Tinnitus

Fatima T. Husain[1,2,3] · Rafay A. Khan[2,3]

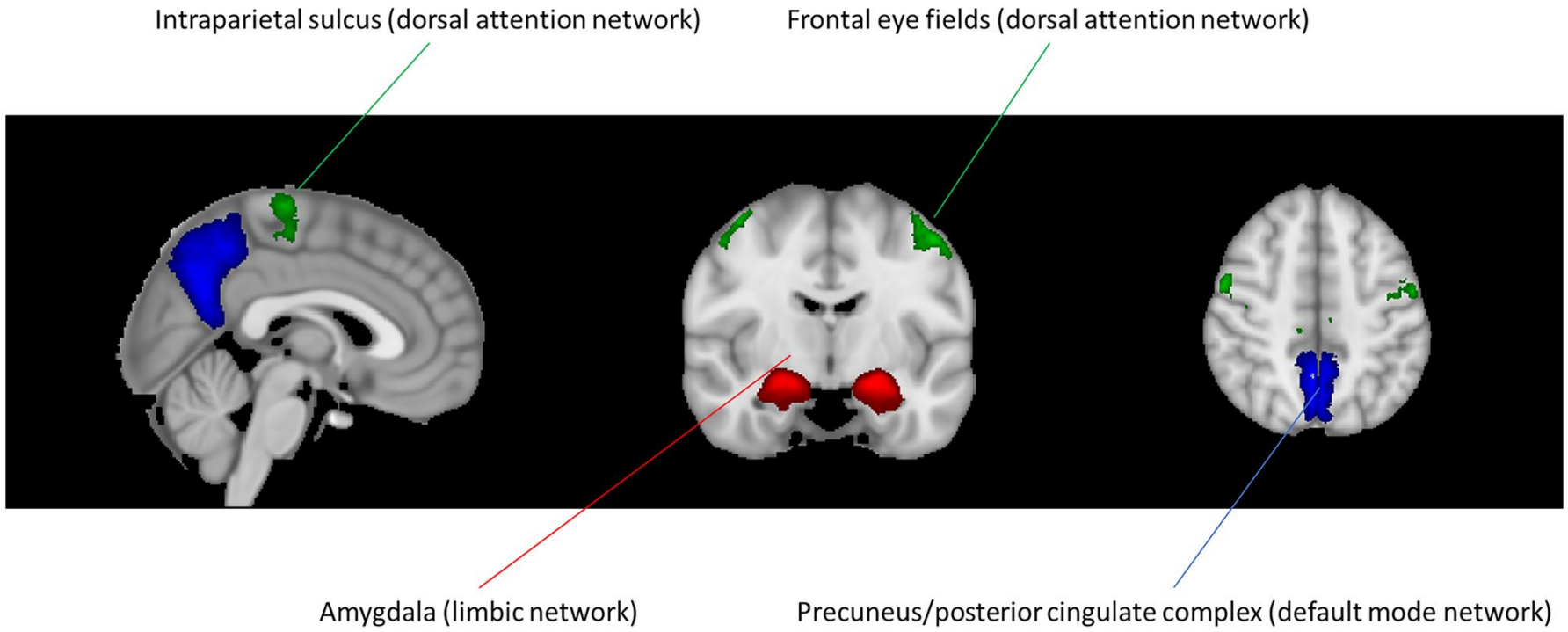


Fig. 2 Modifications des réseaux fonctionnels en présence d'acouphènes. Ces régions (et leurs réseaux) ont été observées pour montrer les altérations les plus cohérentes de la connectivité fonctionnelle en présence d'acouphènes. de l'acouphène. Nous émettons l'hypothèse que ces mêmes régions présenteraient des altérations de la connectivité fonctionnelle à la suite d'un traitement efficace en raison de changements significatifs dans la détresse liée à l'acouphène.

- Functional MRI imaging has identified functional networks in the presence of tinnitus
- This clearly shows the alterations in functional connectivity in the presence of tinnitus

SOMATOSENSORY TINNITUS (SST)

Definition

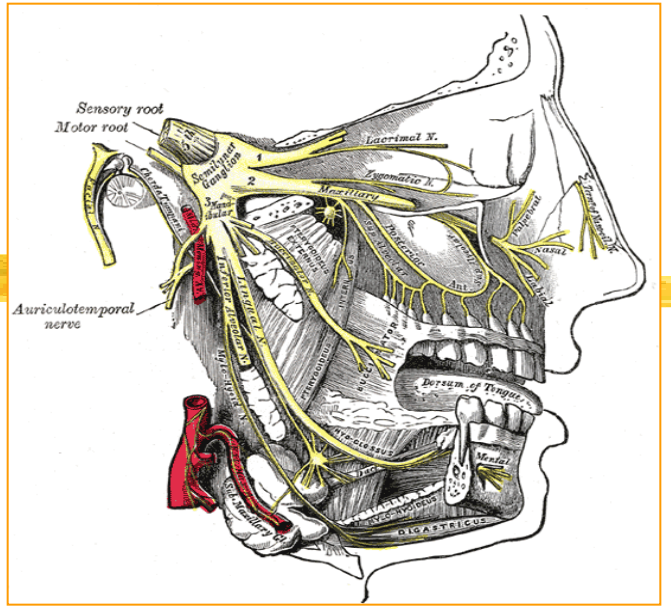
- Subtype of tinnitus, induced or modulated by **somatosensory** (SS),

1ère publication (1999): Levine suggests that somatic stimuli can "disinhibit" the cochlear nucleus (CN) and produce excitatory activity in the auditory pathways and facilitate tinnitus.

- Numerous studies have demonstrated connections between the sensory and motor systems of the cervical-dorsal regions or the TMJ with the cochlear nucleus.

- The SST is thought to be linked to these inputs, which may lead to interactions with the central auditory system.

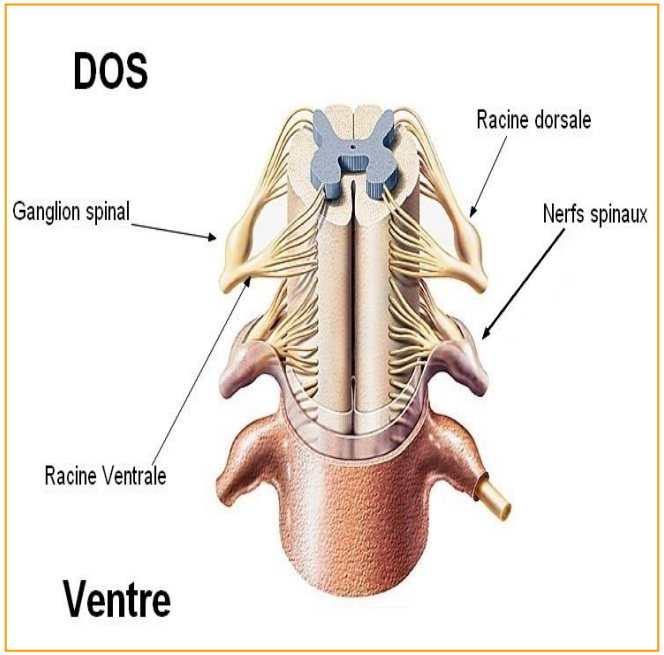
What are the routes?



- **The somatosensory afferent pathways are of equal importance**
  - ➥ Trigeminal tracts: sensitive innervation, face, neck and mouth
  - ➥ Cervical and dorsal spine pathway = innervation of the back of the head, neck and upper limbs

Axons of 1er order: derive from the trigeminal ganglion and dorsal root ganglia

Axons of 2ème order: spts relays trigemino spinal nucleus and dorsal column nuclei, in the brainstem



What about fibers?


Hearing Research

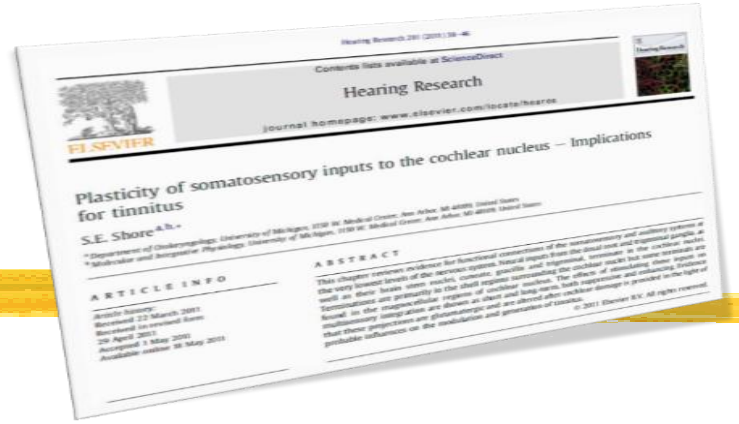
Plasticity of somatosensory inputs to the cochlear nucleus – Implications for tinnitus

S.E. Shore

- The axon/neuron connection is made by glutamate = glutamatergic fibres
- Two categories of *"transporter"* vesicles have been identified: $VGLUT_1$ and $VGLUT_2$, which have different distributions in the cochlear nucleus.
- Fibres from the cochlea are glutamatergic $VGLUT_1$ *[Zhou, 2007]*
- Fibres from somato-sensory inputs are $VGLUT_2$ *[ZeNG*

Suggests that these two excitatory synapses function differently.

What about in CN after lesion of inner ear ?


Hearing Research

Plasticity of somatosensory inputs to the cochlear nucleus — Implications for tinnitus

S.E. Shore

- Increased $VGLUT_2$ in regions receiving terminal somatosensory inputs *[Shore, 2008 ,2011,2013,2015]*
- Reduction in $VGLUT_1$ receiving auditory inputs in the CN

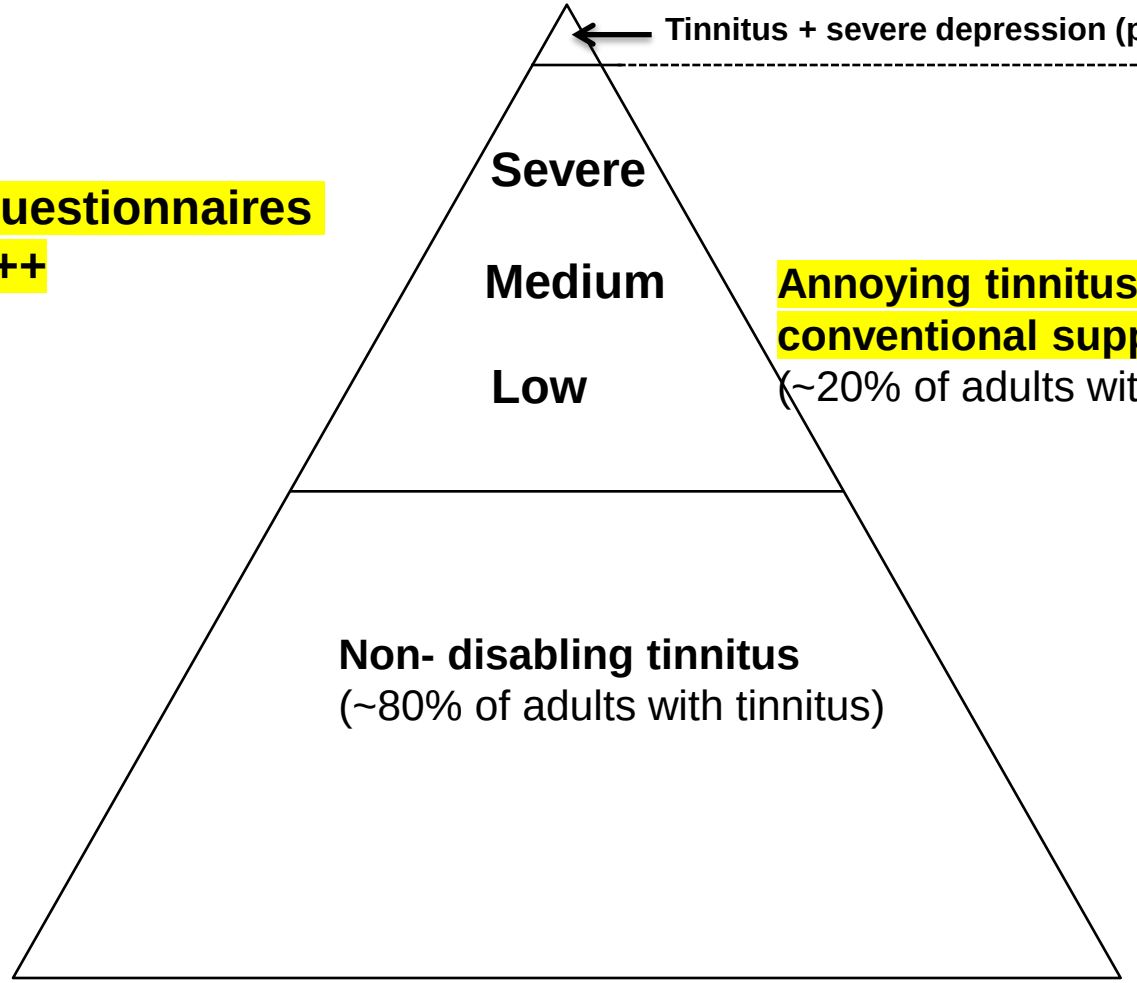
  → imbalance in bimodal integration
- Hypersynchrony.

- We know that multi-sensory neurons have a great capacity after sensory deprivation to establish cross-modal compensation *(e.g. lip-reading/total deafness; vision/vestibular destruction).*

The medical care needs to be adjusted...

Population adults tinnitus (10-15% of the population)

Questionnaires +++



Annoying tinnitus requiring conventional support
(~20% of adults with tinnitus)

AFREPA
ASSOCIATION FRANCOPHONE DES EQUIPES PLURIDISCIPLINAIRES EN ACOUPHÉNOLOGIE

THI

QUESTIONNAIRE ACOUPHENES

NOM :..... Prénom : .....
Date de naissance : ..... Téléphone : .....

	THI	Oui	Parfois	Non
1F	A cause de votre acouphène, vous est-il difficile de vous concentrer ?	❒	❒	❒
2F	A cause de l'intensité de votre acouphène, vous est-il difficile d'entendre les personnes qui vous entourent ?	❒	❒	❒
3E	Votre acouphène, vous rend-il coléreux ?	❒	❒	❒
4F	Vous sentez-vous l'esprit confus à cause de votre acouphène ?	❒	❒	❒
5C	A cause de votre acouphène, vous sentez-vous désespéré ?	❒	❒	❒
6E	Vous plaignez-vous beaucoup de votre acouphène ?	❒	❒	❒
7F	A cause de votre acouphène, avez-vous du mal à trouver le sommeil la nuit ?	❒	❒	❒
8C	Votre acouphène interfère t'il dans votre plaisir à pratiquer des activités sociales (allez au restaurant, au cinéma...) ?	❒	❒	❒
9F	Votre acouphène interfère t'il dans votre plaisir à pratiquer des activités sociales (allez au restaurant, au cinéma...) ?	❒	❒	❒
10E	A cause de votre acouphène, vous sentez-vous frustré ?	❒	❒	❒
11C	A cause de votre acouphène, avez-vous le sentiment d'être atteint d'une grave maladie ?	❒	❒	❒
12F	A cause de votre acouphène, vous est-il difficile de profiter pleinement de la vie ?	❒	❒	❒
13F	Votre acouphène, interfère t'il dans vos responsabilités au travail ou à la maison ?	❒	❒	❒
14E	Trouvez-vous que vous êtes souvent irritable à cause de votre acouphène ?	❒	❒	❒
15F	A cause de votre acouphène, vous est-il difficile de lire ?	❒	❒	❒
16E	Etes-vous contrarié ou boulversé par votre acouphène ?	❒	❒	❒
17E	Pensez-vous que votre problème d'acouphène a installé un stress dans vos relations avec les membres de votre famille ou vos amis ?	❒	❒	❒
18F	Vous est-il difficile de vous concentrer sur autre chose que votre acouphène ?	❒	❒	❒
19C	Pensez-vous ne pas avoir de contrôle sur votre acouphène ?	❒	❒	❒
20F	A cause de votre acouphène, vous vous sentez souvent fatigué ?	❒	❒	❒
21F	A cause de votre acouphène, vous sentez-vous déprimé ?	❒	❒	❒
22E	Votre acouphène vous rend-il anxieux ?	❒	❒	❒
23C	Pensez-vous ne plus pouvoir faire face à votre acouphène ?	❒	❒	❒
24F	Votre acouphène s'aggrave t'il quand vous êtes stressé ?	❒	❒	❒
25E	Votre acouphène vous donne t'il un sentiment d'incertitude ?	❒	❒	❒

B.A.H.I.A.

Indiquez, pour vous, l'importance de chaque problème (entourez la réponse appropriée) :

	Pas de problème					Problème très important
Acouphène	0	1	2	3	4	5
Perte d'audition	0	1	2	3	4	5
Sensibilité aux sons	0	1	2	3	4	5
Gêne faciale	0	1	2	3	4	5

◆ Présentez-vous une surdité ? ❒ Oui ❒ Non
➡ **Si oui :** ❒ Oreille droite
❒ Oreille gauche
❒ Des 2 oreilles

◆ Considérez-vous votre surdité comme :

	Oreille droite	**Oreille gauche**
➡ Légère	❒	❒
➡ Moyenne	❒	❒
➡ Sévère	❒	❒
➡ Profonde	❒	❒

◆ Votre surdité est-elle :

	Oreille droite	**Oreille gauche**
➡ Récente	❒	❒
➡ Plus ancienne	❒	❒

◆ **Commentaires** :

< 18: No disability (Grade 1).
18-40: Mild handicap (Grade 2).
41-57: Medium disability (Grade 3).
58-77: Severe disability (Grade 4).
> 78: Major disability (Grade 5).

Areas for consideration 6 points

JOURNÉE DE L'AUDITION
Organisée par la SFORL

The Lancet / Neurology 2013; Vol 12, Sept: 920-930

Tinnitus : causes and clinical management

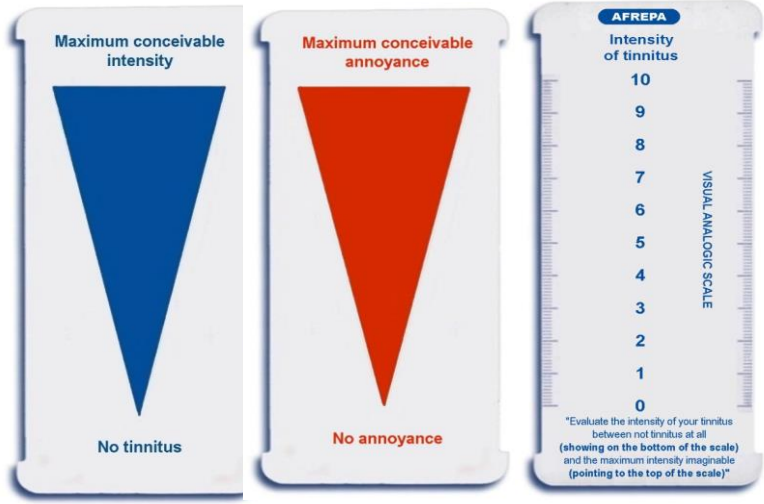
Berthold Langguth, Peter M Kreuzer, Tobias Kleinjung, Dirk De Ridder

J Psychosom Res 2012; 73: 112-21

Methodological aspects of clinical trials in tinnitus: a proposal for an international standard

Landgrebe M, Azevedo A, Baguley D, and al.

- Type of tinnitus
- Circumstances of occurrence
- Associated signs
- Context and psycho-emotional repercussions
- Pure tone and speech audiometry
- Questionnaires THI ,TRQ and VAS (visual analogic scales)



6 points :

- **1/Precise description**: pulsatile or not , permanent or intermittent, fluctuating, frequency (high, low multi-frequential), modulated or not, uni or bil . intensity and discomfort ,

- **2/Circumstances of onset**: sudden (*with sudden hearing loss*
  - ✓Traumatic event (*sound trauma, barotrauma, CT, cervical trauma)*
  - ✓Infectious episodes (*otitis, nasopharyngitis, sinusitis, etc.)*
  - ✓High blood pressure flare-up, discovery of diabetes, hyperthyroidism
  - ✓Recent ototoxic treatment …..

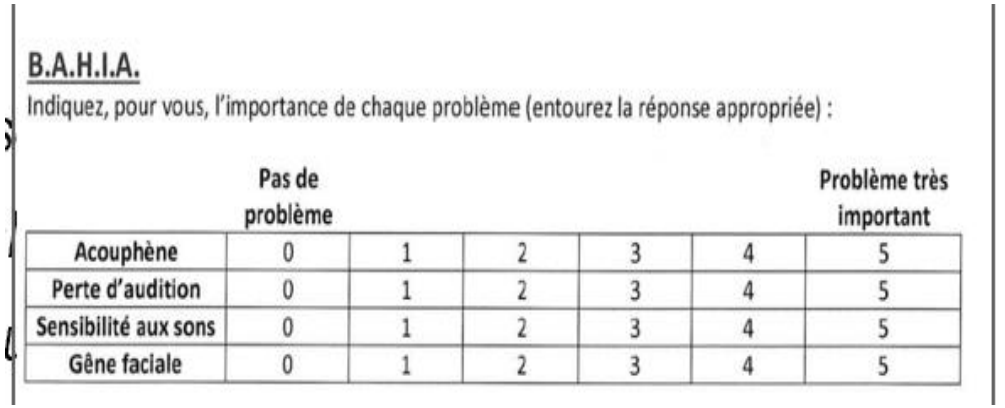
3/Associated signs

JOURNÉE DE L'AUDITION
Organisée par la SFORL

Associated signs

> What is the main complaint?

- ✓ Heraing loss and discrimination disorders ➔ *hearing head and sound therapy*
- ✓ Aural fullness , distortions ➔ *Cochlear hydrops (Meniere's)*
- ✓ Hyperacusis or Misophonia ➔ *Worsening of the disorder (sound therapy)*
- ✓ Earache, mouth opening ➔ *TMJ or dental occlusion problem*
- ✓ Pain syndromes ➔ cervical problem



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Gêne faciale	0	1	2	3	4	5

4 / Context and psycho-emotional impact

- This aspect of tinnitus should not be overlooked in the interview
- Search for :
  - Emotional event (*death, separation, job loss, etc.)*
  - Overwork, burn out , stress ...
  - Ongoing psychiatric treatment
  - Sleep disorders
  - Intercurrent psychiatric pathology
  - Value of the **THI +++ TRQ** impact questionnaire

Validation Assessment of a French Version of the Tinnitus Reaction Questionnaire
A Comparison Between Data From English and French Versions
C;Pham E;Chery-croze S; https//:doi.org/10.1044/jslhr.4301.184

SOMATOSENSORY TINNITUS

Innovations in Tinnitus Research: Original Article

Diagnostic Criteria for Somatosensory Tinnitus: A Delphi Process and Face-to-Face Meeting to Establish Consensus

Trends in Hearing
Volume 22: 1–10
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DOI: 10.1177/2331216518796403
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Sarah Michiels[1,2,3], Tanit Ganz Sanchez[4,5], Yahav Oron[6], Annick Gilles[2,3,7], Haúla F. Haider[8], Soly Erlandsson[9], Karl Bechter[10], Veronika Vielsmeier[11], Eberhard Biesinger[12], Eui-Cheol Nam[13], Jeanne Oiticica[5], Ítalo Roberto T. de Medeiros[5], Carina Bezerra Rocha[5], Berthold Langguth[14], Paul Van de Heyning[2,3,15], Willem De Hertogh[1], and Deborah A. Hall[16,17,18,19]

- **Diagnostic Criteria Consensus** (2018)*:*

3 major items for SST :

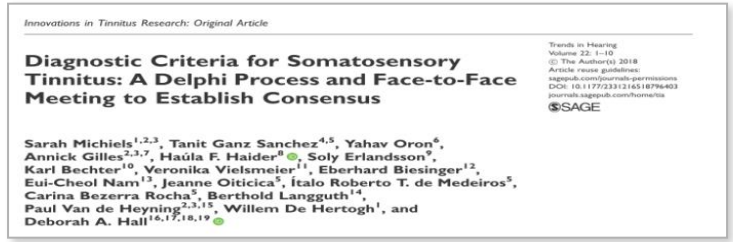
1 - Can be modulated by manoeuvres or movements of the mouth or jaw, head and neck, to be investigated clinically

2 - Presents specific characteristics in relation to the regions causing modulation

3 - Associated symptoms

- Not **all are essential**
- Their presence strongly suggests a somatosensory influence +++.

SOMATOSENSORY TINNITUS


Innovations in Tinnitus Research: Original Article

Diagnostic Criteria for Somatosensory Tinnitus: A Delphi Process and Face-to-Face Meeting to Establish Consensus

Trends in Hearing
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Diagnostic criteria: 2018 consensus

❶ Criteria for modulating Tinnitus

- ✓ Patient able to modulate tinnitus by voluntary movements of the head, neck, jaw or eyes.
- ✓ Modulate by *somatic* manoeuvres *(less frequent: hand, fingers, belt, shoulder)*
- ✓ Modulated by pressure on myofacial trigger points (MTP)

❷ Circumstances of occurrence and characteristics of Tinnitus

- ➢ Tinnitus and neck or jaw complaints appear simultaneously
- ➢ T and neck/jaw pain worsen simultaneously
- ➢ T preceded by head or neck trauma
- ➢ T increases during poor posture
- ➢ **T described as variable in intensity and/or tone or location**
- ➢ **If unilateral tinnitus , the audiogram is not related to the tinnitus frequency**

SOMATOSENSORY TINNITUS

Diagnostic criteria: 2018 consensus

❸ Associated symptoms :

- ✓ frequent neck, head, shoulder or waist pain
- ✓ variations, if MTP pressure
- ✓ hypertonia of the sub-occipital muscles
- ✓ hypertonia of the extensor muscles of the cervical spine
- ✓ temporomandibular joint (TMJ) dysfunction
- ✓ an occlusal dental disorder, bruxism or dental pathology

MANOEUVRES FOR TESTING

Review

Journal of INTERNATIONAL MEDICAL RESEARCH

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Somatosensory tinnitus: Current evidence and future perspectives

Massimo Ralli[1], Antonio Greco[2], Rosaria Turchetta[2], Giancarlo Altissimi[2], Marco de Vincentiis[2] and Giancarlo Cianfrone[2]

- **Jaw movements**
  - ✓ Grit your teeth
  - ✓ Open your mouth wide 2 to 3 times
  - ✓ Tilting the jaw forward
  - ✓ Tilt the jaw to the left Return to the rest position each time
  - ✓ Tilting the jaw to the right

- **Head and neck manoeuvres :**

  Resist pressure on the :
  - ➢ Chin +++
  - ➢ Front Zigoma Dt with head turned to Dte
  - ➢ Occiput Zigoma LH with head turned to LH
  - ➢ Vertex extension and head flexion
  - ➢ Right and left temples Turn head to right and left

Hearing Research

Plasticity of somatosensory inputs to the cochlear nucleus – Implications for tinnitus

S.E. Shore

Summary: Key points in therapeutic choice for ENT specialists

- If permanent bilateral subjective tinnitus :
  1. Importance of tinnitus *(THI, VAS)*
  2. The combination of deafness *(full-tone and speech audiometry)*
  3. The combination of hyperacusis (BAHIA)
  4. Other symptoms (*somatosensory* +++, *Ménière's, headaches, etc.)*
  5. Psychological impact: stress, anxiety, sleep disorders, depression, treatments (HADS)

Recommendations for Tinnitus Care

1/ **Directive advice and patient education,**

2/ **Sound therapy with amplification only in the presence of "significant" deafness (**Cima et al., 2019; National Institute for Health and Care Excellence, 2020; Tunkel et al., 2014).

3/ No official recommendation for White Noise Generators (WNG)

4/ Advise: research projects focusing on the efficacy of sound therapy with rigorous methodologies, randomisation, blinding, control groups and, if possible, against placebo, multi-centred, etc.

1/ **DIRECTIVE COUNCILS is first recommendation**

(NICE 2020; AAOHNS 2019)

- After : 1/ a very detailed interview with an otoscopic examination 2/ selected questionnaires (THI or TFI) and 3/ an audiometric assessment.
- the first essential step in providing appropriate care is **counselling** .
- A simple explanation of the pathophysiological basis of tinnitus, both in general and in relation to each patient, including at least listening, directive advice and patient education on tinnitus.

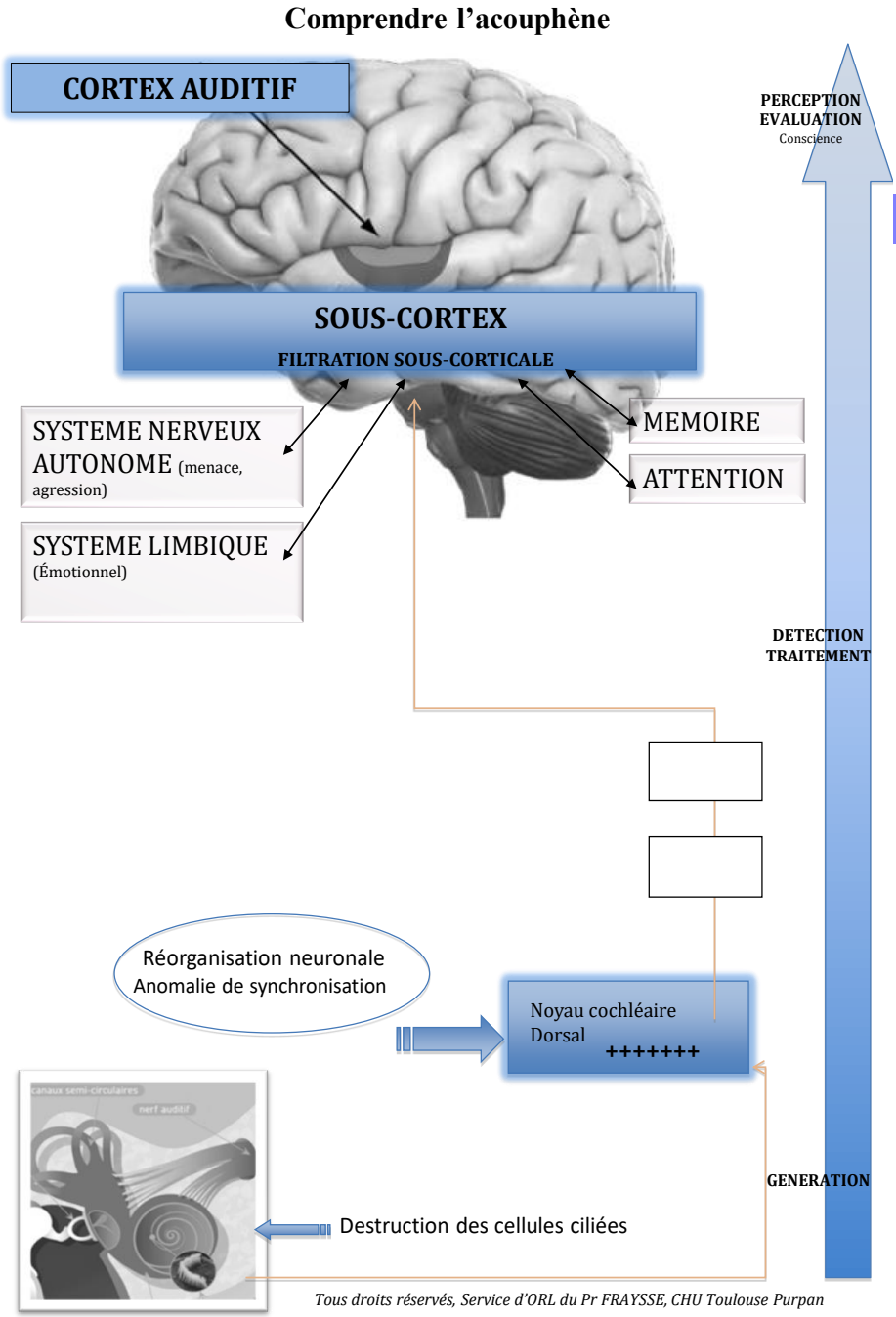
- It can be based on a simple diagram:

COUNCELLING

It is based on a simple diagram:

- the principle of neuroplasticity **involving the cochlear nucleus**
- the involvement of non-auditory pathways to understand the psycho-emotional repercussions, to a greater or lesser extent
- the different types of tinnitus
- factors that can aggravate or improve tinnitus as sound enrichment , protection of sound trauma and avoid the attentional focus

With listening and empathy for all patients ++.



Key points in the choice of treatment for ENT specialists

1. The importance of tinnitus :

THI < 40
VAS a < 6

- Councelling with explanatory diagrams
- Psychological basis
- Sound enhancement (White noise, water .. Etc)

No sound therapy with hearing aids unless there is associated deafness and or discrimination is impaired

THI > 40
VAS a ≥ 6

- Automatic sound therapy with or without deafness
- Sound générators if no hearing loss
- Hearing aid with amplification, depending on hearing loss
- Sophrology and/or Cognitive Behavorial therapy (CBT)

BAHIA questionnaire +++

Role of the hearing aid acoustician

- Relaying and reinforcing directive advice from other members of the team
- Hearing tests prior to Sound Therapy (SSI, tinnitus).
- Implementation of sound therapy :
  - ↳ Monitoring and adapting the stimulation strategy.
- Monitoring patient progress (common tools) with feedback to the team or ENT specialist

Key points in the choice of treatment for ENT specialists

2. The combination of hyperacusis :

- GBB sound therapy, but beware of amplification if deafness is a factor
- Discomfort threshold, necessary
- BAHIA questionnaire +++, Nelting
- Sophrology and/or CBT depending on distress and anxiety

3. Psychological impact :

- DET (psychological distress) and HADS questionnaires
- Sleep disorders to be assessed
- Use of hypnotics, anxiolytics or antidepressants should be investigated

  ↳ Sophrology ...

  ↳ CBT ...

The essentials for referring patients for psychological care

Sophrology :

A conscious, dynamic method for managing stress independently

Work on breathing and letting go

CBT

Lack of awareness of the disorder, negative thoughts: psycho-education phase

Anxiety disorders (OCD, social phobias, avoidance, massive isolation, obesity)

Moderate to severe depressive disorders (CBT as first-line treatment for mood disorders)

Helps you understand how to live with a problem

Supportive and analytical psychology

Depression, burn-out, post-traumatic stress disorder

Gives meaning, answers the "why" question

Psychiatry

Depending on the seriousness of the situation and the need for specific medication

Key points in the choice of treatment for ENT specialists

4. If tinnitus with somatosensory involvement :

- History, cervical trauma
- No hearing loss or symmetrical
- Variations in intensity and frequency, modulated by movements
- Specific circumstances for stopping
- Recurring pain

TTT

- Muscle relaxants ± anti inflammatory
- Osteopathy + maxillofacial and cervical physiotherapy
- Physical medicine
- Dentist + occlusodontist if suggestive signs on clinical examination

± Sophrology

UNIVERSITÉ TOULOUSE III – PAUL SABATIER
ÉCOLE D'AUDIOPROTHÈSE DE CAHORS

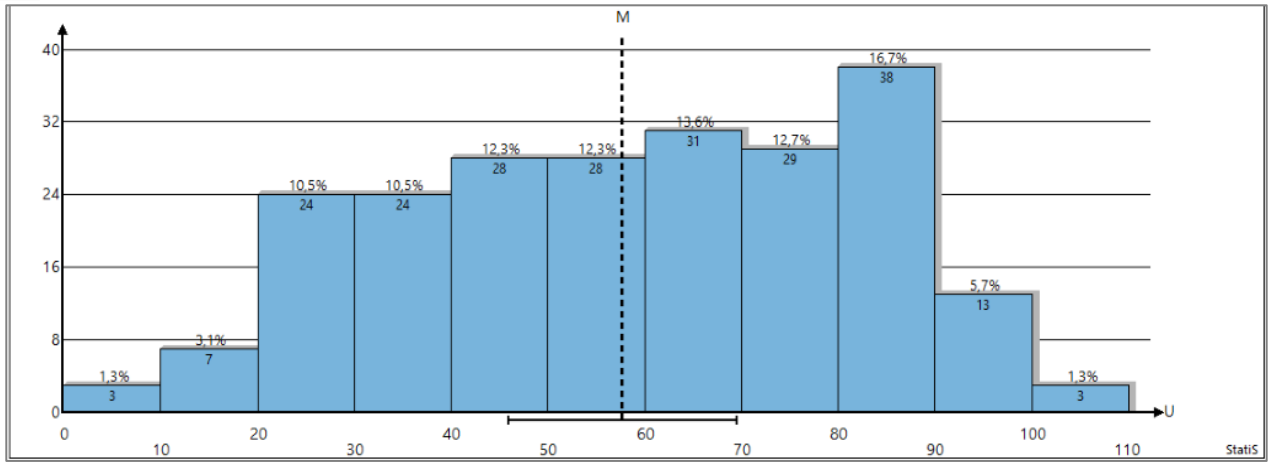
Étude rétrospective de l'évolution d'une cohorte de patients acouphéniques vus en consultation multidisciplinaire :
Analyse des prises en charge et résultats

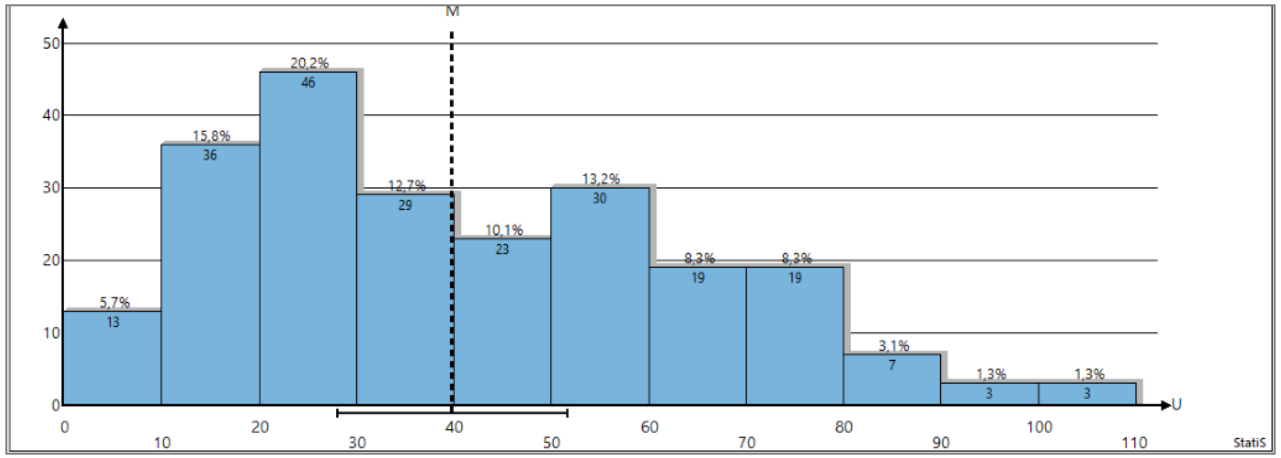
Mémoire présenté en vue de l'obtention du
DIPLÔME D'ETAT D'AUDIOPROTHÉSISTE
Soutenu le 20 Septembre 2018 par
Pauline ROGER

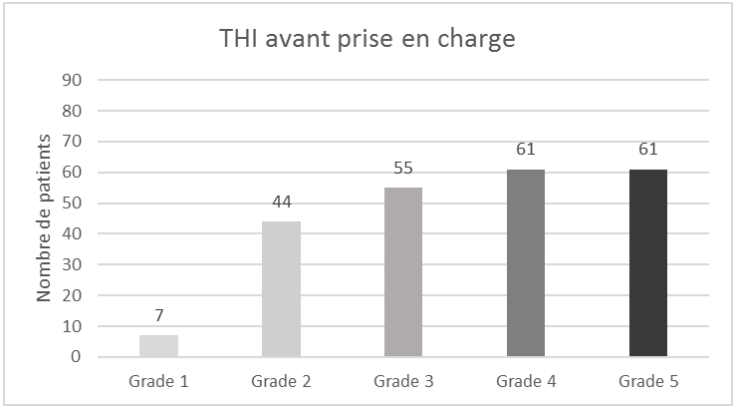
Maître de mémoire : Docteur Marie-José ESTÈVE – FRAYSSE
Co-maître de mémoire : Monsieur Morgan POTIER

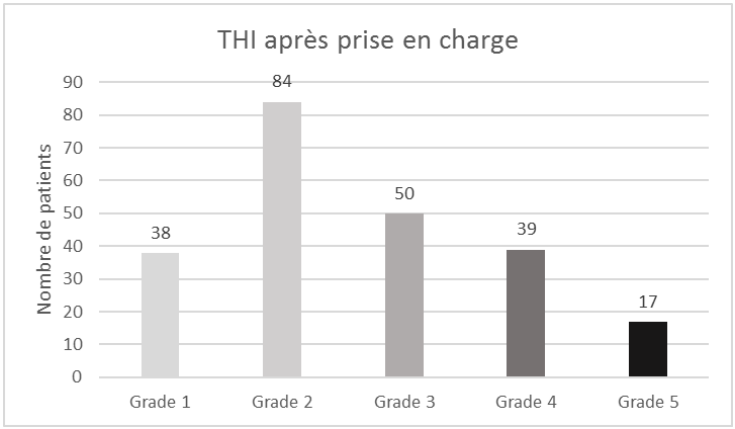
Evaluation of patients seen in multidisciplinary SC / before and 6 to 12 months after the start of treatment

- Patients' THI grades before and after treatment:







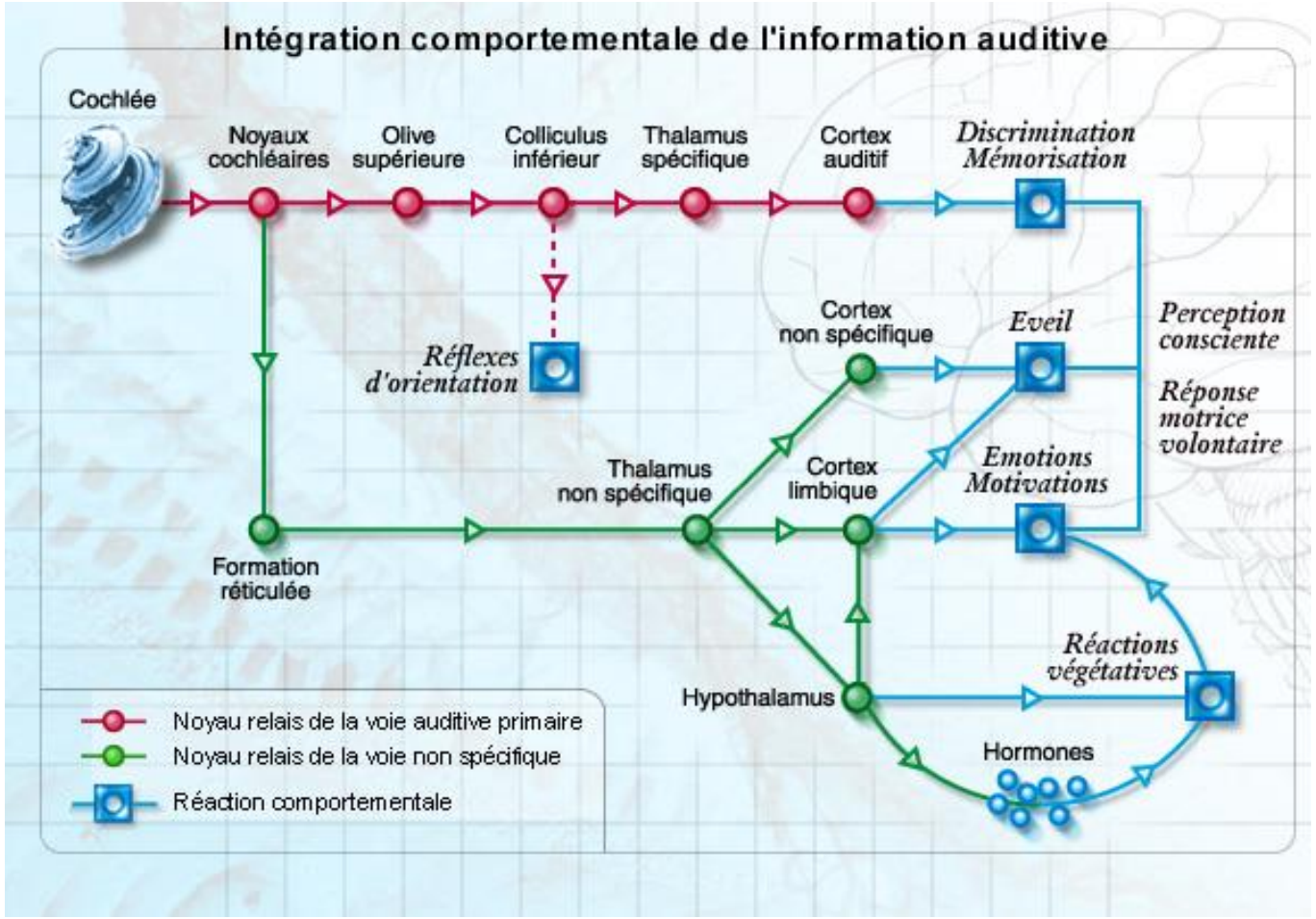


Ideal multidisciplinary care tailored to each patient

- Avoid the "there's nothing you can do, you'll have to learn to live with it .!!
- Avoid dream merchants: various and successive anti-epileptics, or magical and expensive stays .....

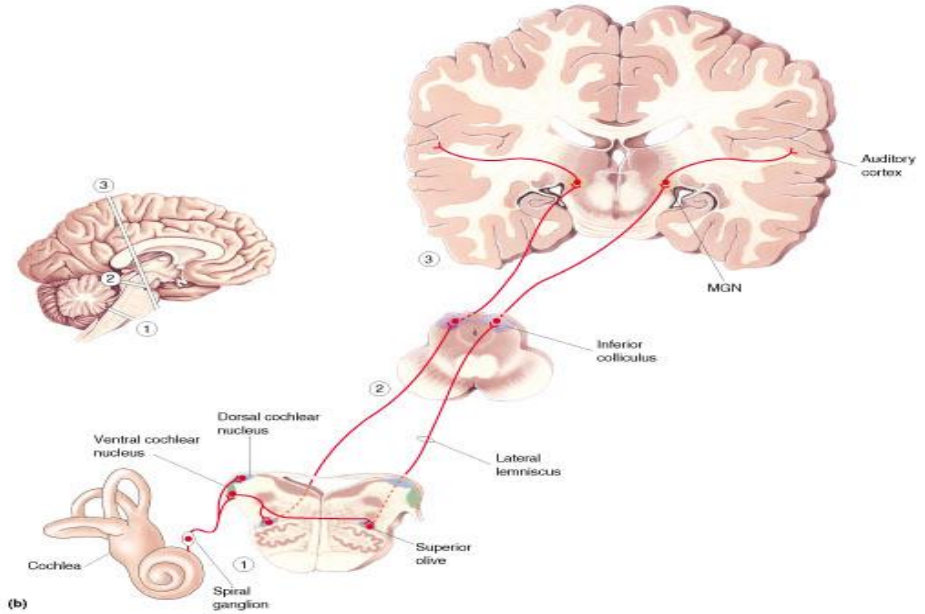
- Use counselling with listening and empathy for all patients
- Prefer fitting hearing aids taking into account the specific problem of each tinnitus, with an appropriate follow-up...
- Remenber Sophrology or Psychotherapy taking into account the type of tinnitus, the associated clinical signs, the circumstances in which it occurred, etc. and the emotional consequences in quality of life

Non-auditory pathways



SOMATOSENSORY TINNITUS

The cochlear nucleus / CN



- **The cochlear nucleus is a site of tinnitus induction when auditory nerve inputs decrease:**
  - **CN is prepared to induce these processes:**
  - Presence of output neurons (spindle cells) high synaptic plasticity, allows integration of multisensory information

- **Somatosensory inputs are excitatory:** glutamatergic (GLU)
  - Constitute a reservoir that can be "activated" during homeostatic variations