Program and Abstracts

Sixth International Conference on Tinnitus

Tinnitus: The Art and Science of Innovation

Organized by the
Tinnitus Research Initiative Foundation
&
The TRI Tinnitus Unit Antwerp, Belgium,

part of Brain Research center Antwerp for Innovative and Interdisciplinary Neuromodulation (BRAI2N), Antwerp University Hospital & Antwerp University

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The organizers want to thank the people who have helped organizing this Conference, especially Marina Pieters in Bruges and Susanne Staudinger and Sylvia Dorner-Mitschke in Regensburg.

Welcome to TRI2012

As the host of the sixth international TRI Tinnitus Conference we welcome you to Brugge.

If we want to find a cure for tinnitus within a short timeframe, classical science alone will not suffice. We need to involve people who think innovatively, and not only creative scientists from other research domains, but also natural innovators such as artists and philosophers. Even though they are not directly involved in tinnitus research, these innovators can help us by Socrates discussions to generate novel conceptual ideas of what phantom perceptions are, and how they arise. The integration of science and innovative exploration goes back to the very foundational spirit of the TRI when it was conceived by Matteo de Nora. Inviting creative scientists from other fields has also been a tenet in these meetings, and TRI Brugge 2012 definitely has this aspiration. The aim of the TRI2012 meeting is to explore the notion that art, philosophy and science are different sides of the same coin and use different but complementary approaches to seeing and solving a problem. Thus, by joining forces make a quantum leap in our journey towards a cure for tinnitus.

It is a great pleasure to introduce you to Brugge. The city of Bruges is a World Heritage Site of UNESCO, and since the Middle Ages considered the 'Venice of the North'. Upon visiting Bruges, you will immediately notice that this city has always carefully cherished its architectural and artistic treasures from the past. The current city boundaries still coincide exactly with those of the medieval city center, and the spaces and structures that were so typical of Bruges in the past have been preserved. Take your time to walk through busy squares, refreshing parks, and quiet, intimate cobbled streets, and do not forget to visit the modest almshouses as well as the imposing patrician's homes.

We hope you will enjoy your visit to Brugge and that the Conference will provide you with novel ideas on tinnitus, perhaps leading to innovative studies on the pathophysiology and treatments for the benefit of patients with this enigmatic disease.

Dirk De Ridder, Ana Belen Elgoyhen, Berthold Langguth,
Paul Van de Heyning & Sven Vanneste

Brugge, June 2012

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09:45 am		**Invited Speaker:** *Vertigo as a vestibular phantom percept* **Floris Wuyts**		**Invited Speaker:** *Hyperacusis, misophonia and phonophobia* **Aage Møller**		**Invited Speaker:** *The future of medicine - A marketing perspective* **Jens Gutsche**	
10:15-11:45 am		Coffee Break					
10:45 am		**Session 1: Treatment** Chair: C. Coelho	**Session 2: Auditory & Cognitive Changes** Chair: S. Hébert	**Session 5: Treatment** Chair: M. Kilgard	**Session 6: Auditory & Cognitive Changes** Chair: L. Roberts	**Session 9: Functional Imaging** Chair: T. Cacace	**Session 10: Auditory & Cognitive changes** Chair: D. Hall
12:45-01:45 pm		Lunch					
01:45 pm		**Keynote Speaker:** *Tinnitus: brain activity and connectivity* **Nathan Weisz**		**Keynote Speaker:** *The neural correlates of conscious percepts* **Steven Laureys**		**Keynote Speaker:** *Nihil nove sub sole: filling in the boxes of the neurophysiological tinnitus model* **Pawel J. Jastreboff**	
02:30 pm		**Invited Speaker:** *A Technology Push for Electrical Neuromodulation* **Wouter Serdijn**		**Keynote Discussion:** *Art vs. Science* **Jan Fabre - Gyorgy Buzsáki**		**Closing session:** **Berthold Langguth**	
03:00 pm		Coffee Break					
03:15 pm				Coffee Break			
03:30 pm		**Invited Speaker:** *Subjective tinnitus, illusions, arts, and virtual worlds* **Alain Londero**					
03:45 pm				**Invited Speaker:** *Is the University the right place for innovation? A historical approach* **Hilde Symoens**			
04:00 pm		**Session 3: Pathophysiology** Chair: S. Shore	**Session 4: Functional Imaging** Chair: W. Schlee				
04:15 pm				**Session 7: Treatment** Chair: R. Tyler	**Session 8: Pathophysiology** Chair: G. Searchfield		
05:30 pm	**Opening registration desk**	**Poster Session** &					
06:30 pm		Apéro		*Picasso Exhibition*			
07:30 pm							
08:00 pm	**Openings Speaker:** *Academic Freedom* **Rik Torfs**			*Banquet*			
09:00 pm	**Musical intermezzo** *Arias* **Valerie Peeters**						
09:10 pm	*Welcome Cocktail*						

DETAILED SCIENTIFIC PROGRAM

	Wednesday, June 13
05:30- 08:00 p.m.	**Opening registration desk**
08:00 - 09:00 p.m.	**Openings Speaker** *Academic freedom: separation from religion AND state?* ***Rik Torfs***
09:00- 09:10 p.m.	**Musical intermezzo** *Arias* ***Valerie Peeters***
09:10 p.m. - …	*Welcome Cocktail*

	Thursday, June 14	
09:00 - 09:45 a.m.	**Keynote Speaker** *Tinnitus: from Cochlea to Cortex* ***Paul Van de Heyning***	
09:45 - 10:15 a.m.	**Invited Speaker** *Vertigo as a vestibular phantom percept* ***Floris Wuyts***	
----------Coffee Break (30 min)---------Coffee Break (30 min)----------Coffee Break (30 min)----------		
10:45 am - 12:45 p.m.	**Session 1: Treatment** **Chair: Claudia Coelho** *(Room: Morus)*	**Session 2: Auditory & Cognitive Changes** **Chair: Sylvie Hébert** *(Room: Erasmus)*
	1 ***Nam E.C., Han S.S., Won J.Y., Lee K.U., Chun W., Choi H.K., Levine R.A.:*** *Clonazepam Quiets Tinnitus: a Randomized Crossover Study with Ginkgo Biloba* 2 ***Smith P.F., Vagal, S., McNamara E., Darlington C.L., Zheng Y.:*** *Effects of L-BACLOFEN on Chronic Tinnitus induced By Acoustic Trauma In Rats* 3 ***Coelho C., Witt S., Ji H., Marlan Hansen M., Gantz B. J., Tyler R.:*** *Zinc to Treat Tinnitus in the Elderly: a randomized placebo controlled crossover trial* 4 ***Azevedo A., Vanneste S., De Ridder D.:*** *The effect of naltrexone on the perception and distress in tinnitus: An open label pilot study* 5 ***Depireux D.:*** *Preventing the emergence of tinnitus post-trauma with drug-loaded nanoparticles* 6 ***Van de Heyning P., Cox T., Maier H., Muehlmeier G., Morawski K., Lisowska G., Meyer T.:*** *Efficacy and safety of AM-101 in the treatment of acute inner ear tinnitus – A Double Blind, Randomised, Placebo Controlled Phase II Study*	1 ***Shi-Nae Park, Seong-Cheon Bae, Kyoung-Ho Park, Sang-Won Yeo:*** *Clinical Characteristics and Therapeutic Response of Objective Tinnitus due to Middle Ear Myoclonus: A Large Case Series* 2 ***Hall D.A., Wallenhorst C., Martinez C.:*** *The incidence of disabling tinnitus: A population-level Uk cohort Study* 3 ***Wallenhorst C., Martinez C., Hall D.A.:*** *Risk factors for developing a disabling tinnitus: A populaiton-level UK cohort study* 4 ***Kam A.C.S., Sung J.K.K., Lee T., Wong T.K.C., van Hasselt C.A.:*** *Clinical evaluation of a computerized self-administered tinnitus measurement system* 5 ***Fournier P., Basile C-E., Hutchins S. & Hébert S.:*** *Improving tinnitus pitch matching: implications for neurophysiological models and clinical practice* 6 ***van Gendt M.J., Boyen K., de Kleine E., van der Laan B.F.A.M., Langers D.R.M., van Dijk P.:*** *Psychoacoustics and neural correlates of gaze-evoked tinnitus*
12:45 - 01:45 p.m.----------LUNCH----------LUNCH----------LUNCH----------		
01:45 - 02:30 p.m.	**Keynote Speaker** *Auditory alpha: from clinical to cognitive neuroscience and back* ***Nathan Weisz***	
02:30 - 03:00 p.m.	**Invited Speaker** *A Technology Push for Electrical Neuromodulation* ***Wouter Serdijn***	
----------Coffee Break (30 min)---------Coffee Break (30 min)----------Coffee Break (30 min)----------		
03:30 - 04:00 p.m.	**Invited Speaker** *Virtual Reality (VR) in subjective tinnitus management* ***Alain Londero***	

04:00 -	**Session 3: Pathophysiology**	**Session 4: Functional Imaging**

05:30 p.m.	**Chair: Susan Shore** *(Room: Morus)*	**Chair: Winfried Schlee** *(Room: Erasmus)*
	1 ***Cacace A.T., Hu J., Romero S., Salamy J., Xuan Y.:*** *Noise-induced tinnitus: Selected neurobiochemiocal, anatomical, and psychometric changes following rTMS including other metabolic-related effects* 2 ***Kidd A.R., Turner J.G., Caspary D. M., Bao J.:*** *GABA signaling components in the MGB and hippocampus of rats with chronic tinnitus* 3 ***Cederroth C.R., Hudspeth A.J.:*** *Genetic evidence for the contribution of glutamate in ototoxic-mediated hearing loss and tinnitus* 4 ***Dehmel S., Parikh M., Bledsoe S.C., Shore S.E.:*** *Changes in Somatosensory-Auditory Integration in Inferior Colliculus Accompany Noise Induced Tinnitus* 5 ***Grafton G., Ahmed S.R., Brouard J., Lobarinas E., Salvi R., Barnes N.M.:*** *Role of the 5-HT system in tinnitus: a systematic study using an animal model from Neurodynamical Multiscale Modeling* 6 ***Heeringa A.N., Segenhout J.M., Van Dijk P.:*** *The acute and chronic effect of noise trauma on neuronal activity in the inferior colliculus of the guinea pig.*	1 ***Schlee W., Vanneste S., De Ridder D., Langguth B., Kolassa I-T.:*** *Do aging processes affect tinnitus perception and distress?* 2 ***Delb W.:*** *Are Tinnitus Related Distress and Tinnitus Loudness Distinct Tinnitus Features or Just Two sides of the Same Medal? Results from Epidemiological, EEG- and fMRI- Studies* 3 ***Song J.J., Vanneste S., Van de Heyning P., De Ridder D.:*** *"Distressed aging": The differences in brain activity between early- and late onset tinnitus* 4 ***Geven L.I., De Kleine E., Paans A. M. J., Willemsen A.T.M., Van Dijk P.:*** *Asymmetry in primary auditory cortex activity in tinnitus patients and controls* 5 ***Maudoux A., Vanneste S., De Ridder D., Vanhecke W., Van de Heyning P., Cabay J.-E., Demertzi A., Laureys S., Soddu A., Lefebvre Ph., Gomez F.:*** *Investigating the Tinnitus Brain Using Resting-state fMRI* 6 ***Husain F.:*** *The Effect of Tinnitus on Resting State Functional Connectivity*
05:30 – 07:30 p.m.	**Poster Session** & *Apéro*	

Friday, June 15

09:00 - 09:45 a.m. — **Keynote Speaker**
Neural syntax: what does music offer to neuroscience (and vice versa)
Gyorgy Buzsáki

09:45 - 10:15 a.m. — **Invited Speaker**
Neurophysiological aspects on Misophonia, Phonophobia, Hyperacusis and Exploding Head Syndrome
Aage Møller

----------Coffee Break (30 min)---------Coffee Break (30 min)----------Coffee Break (30 min)----------

10:45 a.m. - 12:45 p.m.

Session 5: Treatment
Chair: Michael Kilgard
(Room: Morus)

1. ***Ylikoski J., Lehtimäki J., Malkavaara K., Ylikoski M., Yrttiaho S., Mäkelä J.:*** *Sound therapy plus Transcutaneous Vagus Nerve Stimulation in the treatment of patients with tinnitus.*
2. ***Kilgard M.P., Vrana W.A., Borland M.S., Vanneste S., De Ridder D., Sloan A.M., Rennaker R.L.:*** *Optimizing VNS-Directed Neural Plasticity for the Treatment of Chronic Tinnitus*
3. ***Vanneste S., Kilgard M., Engineer N., Tarver B., De Ridder D.:*** *Paired vagus nerve stimulation for tinnitus - Pilot study results*
4. ***Viaud-Delmon I., Londero A., Bonfils P., Warusfel O.:*** *Virtual reality exposure therapy for unilateral tinnitus*
5. ***Shlamkovitch N.:*** *The effect of Hyperbaric Oxygen Treatment (HBOT) on post traumatic central-type chronic disabling tinnitus*
6. ***Perrot X., Simon E., Roche L., Fornoni L., Richard S., Dubreuil C., Truy E., Norena A., Boissel J.P., Roy P., Collet L., and on behalf of the MagTIN study group:*** *Safety and efficacy assessment of conventional low- and high-frequency repetitive transcranial magnetic stimulation for the treatment of chronic tinnitus: Dosimetric approach*

Session 6: Auditory & Cognitive Changes
Chair: Larry Roberts
(Room: Erasmus)

1. ***Rabau S., Gilles A., Kleine Punte A., Waelkens B., Wouters K., Cox T., Janssens de Varebeke S., Van de Heyning P.:*** *Correlation between the psychoacoustic measurement, questionnaires and patient global impression of change in patients with acute tinnitus*
2. ***Roberts L.E., Thompson D.C. , and Bosnyak D.J****.: Neural plasticity in central auditory structures is expressed differently in tinnitus*
3. ***Meltser I., Ek B., Hébert S., & Canlon B.:*** *Central gain: Behavioural and biological responses in two strains of mice*
4. ***Salvi R., Chen G.-D. , Manohar S.:*** *Salicylate Induces Hyperactivity and Tonotopic Shift in Amygdala and Auditory Cortex*
5. ***Rüttiger L., Singer W., Zuccotti A., Panford-Walsh R., Matsumoto M., Zimmermann U., Jaumann M., Franz C., Geisler H.-S., Köpschall I., Rohbock K., Xiong H., Varakina K., Lee S.C. , Verpoorten S., Schimmang T., Knipper M.:*** *Molecular basis of tinnitus*
6. ***Wallhäusser-Franke E., Delb W.:*** *Tinnitus and Insomnia: Is hyperarousal the common denominator?*

12:45 - 01:45 p.m.----------LUNCH----------LUNCH----------LUNCH----------

01:45 - 02:30 p.m. — **Keynote Speaker**
The neural correlates of conscious percept
Steven Laureys

02:30 - 03:15 p.m. — **Keynote Discussion**
Art vs. Science
Jan Fabre - Gyorgy Buzsáki

----------Coffee Break (30 min)---------Coffee Break (30 min)----------Coffee Break (30 min)----------

03:45 - 04:15 p.m. — **Invited Speaker**
Is the University the right place for innovation? A historical approach
Hilde De Ridder-Symoens

04:15 - 05:30 p.m.

Session 7: Treatment
Chair: Richard Tyler
(Room: Morus)

1. ***Baumann U., Helbig S., Stöver T.:*** *Mechanically Induced Tinnitus Observed in Cochlear Implant Users with Residual Hearing*
2. ***Viirre E. :*** *Neuroethical issues in tinnitus research and care*
3. ***Arnold R., Roggerone M.A.C., Bouma J., Van Dijk P.:*** *Multidisciplinary assessment and treatment of tinnitus: A Follow-up study*
4. ***Tyler R., Walker K., Witt S., KillianM., Dillier N., van Dijk P., Lai W.K.:*** *Tinnitus suppression with mixed background stimuli in a wearable cochlear implant*
5. ***Kleine Punte A., Hofkens A., Mertens G., De Bodt M., Van de Heyning P.:*** *Sustained suppression of severe tinnitus with MED-EL cochlear implants in single-sided deafness:8 years experience*

Session 8: Pathophysiology
Chair: Grant Searchfield
(Room: Erasmus)

1. ***Estola M.:*** *Kinesia taping to treat tinnitus*
2. ***Searchfield G.D., Wise K., Kobayashi K.:*** *Game training of tinnitus*
3. ***Wiener V., Haenecour L.:*** *When and why using vertebral maneuvers as a tinnitus treatment.*
4. ***Desmet J., De Bodt M. and Van de Heyning P.:*** *Tinnitus in patients with single sided deafness prior to and after a bone conduction device trial*
5. ***Tass P.A., Adamchic I., Hauptmann C.:*** *Counteracting tinnitus symptoms and related cerebral synchony by acoustic CR neuromodulation*

05:30 – 06:30 p.m.	
06:30 – 08:00 p.m.	**Picasso Exhibition**
08:00 p.m. - …	***B A N Q UE T***

	Saturday, June 16
09:00 - 09:45 a.m.	**Keynote Speaker** *Mechanisms of tinnitus development: Computational models, experimental tests, and implications for treatment* ***Roland Schaette***
09:45 - 10:15 a.m.	**Invited Speaker** *The future of medicine - A marketing perspective* ***Jens Gutsche***
----------Coffee Break (30 min)---------Coffee Break (30 min)----------Coffee Break (30 min)----------	
10:45 a.m. - 12:45 p.m.	**Session 9 Functional Imaging** **Chair: Tony Cacace** *(Room: Morus)* 1 ***Dietzen T., Balkenhol T., Delb W.:*** *Neurofeedback Treatment in Tinnitus Patients: A Comparative Study of different Treatment Strategies* 2 ***Hartmann T., Lorenz I., Müller N., Langguth B. and Weisz N.:*** *Fire and forget: comparison of the effects of neuromodulaiton by low-frequency rTMS and neurofeedback on oscilatory processes related to tinnitus* 3 ***Golm D., Schmidt-Samoa C., Dechent P., Kröner-Herwig B.:*** *Neural Correlates of Tinnitus Annoyance: Results from an Emotional Stroop Task* 4 ***Benson R.R., Gattu R., Cacace A.T.:*** *Increased Fractional anisotropy (FA) is asymmetric and localized primarily to white matter tracks in the left hemisphere: A diffusion tensor imaging study of noise-induced tinnitus* 5 ***Husain F.:*** *Changes associated with tinnitus and hearing loss in functional brain networks involved in short-term memory and attention* 6 ***Schecklmann M., Tupak S., Zeller J., Harnisch W., Giani A., Fallgatter A.J., Langguth B.:*** *Functional near-infrared spectroscopy as new and innovative neuroimaging tool in tinnitus?* 7 ***Langers D.R.M., De Kleine E., Van Dijk P.:*** *Lack of tonotopic cortical reorganization in tinnitus* 8 ***Wineland A.M., Burton H., Piccirillo J.F.:*** *Functional connectivity networks in tinnitus: The importance of bother*	**Session 10: Auditory & Cognitive changes** **Chair: Deborah Hall** *(Room: Erasmus)* 1 ***Hoover S.:*** *Guide to Diagnosis of the Three Types of Chronic Tinnitus* 2 ***Esteve-Fraysse M.J., Ohresser M, Holer-Houdoux C.H., Branchereau B., Loche V., Pannetier B., Attard A., Geoffray B., Vertallier M., Pantin A.S., Lina-Granade G., Levrat F., Nouri N.:*** *Correlation analysis between visual analogic scale intenisty (VASI) and annoyance (VASA) and 3 Questionnaires STSS (1), TRQ (2) and THI (3) in tinnitus patients: Neural plasticity in central auditory structures is expressed differently in tinnitus* 3 ***Hall D.A., Wan Mohammed N., Stockdale D. (on behalf of the Tinnitus Priority Setting Partnership):*** *Patient and clinical perspectives on unanswered questions about tinnitus treatment: The James Lind Alliance experience.* 4 ***Packer M.D.:*** *Establishing a Hearing Health Improvement Network: The U.S. Department of Defense Hearing Center of Excellence* 5 ***Gilles A., Van Hal G., De Ridder D., Van de Heyning P.:*** *Epidemiology of noise-induced tinnitus in adolescents* 6 ***Advani J., Yágüez-Hervas L., McKenna L.:*** *The effects of tinnitus on working memory* 7 ***Margaret M. Jastreboff, Pawel J. Jastreboff:*** *Decreased sound tolerance (hyperacusis and misophonia): clinical implications* 8 ***Mertens G., Kleine Punte A., De Bodt M., Van de Heyning P.:*** *Does tinnitus affect speech perception in the contralateral ear in patients suffering from single-sided deafness treated by cochlear implantation?*
12:45 - 01:45 p.m.----------LUNCH----------LUNCH----------LUNCH----------	
01:45 - 02:30 p.m.	**Keynote Speaker** *Nihil nove sub sole: filling in the boxes of the neurophysiological tinnitus model* ***Pawel J. Jastreboff***
02:30 - 03:00 p.m.	**Closing Session** ***Berthold Langguth***

Thursday, June 14, 5:30 – 7:30 p.m

Posters

	Pathophysiology
P1.	**Methodological optimization of tinnitus assessment using prepulse inhibition of the acoustic starle reflex** Longenecker R.J., Galazyuk A.V.
P2.	**The biomarker of tinnitus** Goto F., Saruta J., Kanzaki S., To M., Tsutsumi T., Tsukinoki K., Ogawa K.
P3.	**Tinnitus triggered by use of oral ciprofloxacin: case report** Davila D.V., Saba C.M.
P4.	**Behavioral effects of two tinnitus inducers (noise exposure and salicylate) in guinea pigs** Berger J.I., Coomber B., Shackleton T.M., Wallace M.N. & Palmer A.R.
P5.	**Neural and histological correlates of tinnitus in guinea pigs** Coomber B., Berger J., Leggett R.C., Shackleton T.M., Palmer A.R. & Wallace M.N
P6.	**BDNF and GDNF genes exert sexually dimorphic effects on tinnitus symptomatology** Sand P., Langguth B., Vielsmeier V., Landgrebe M., Kleinjung T.
P7.	**Analysis of the association between tinnitus and arterial hypertension: preliminary data** Figueiredo R. R., Azevedo A.A., Penido N.O.
P8.	**Spontaneous firing rates in auditory cortex in response following long-term exposure to non-traumatic auditory stimuli: a potential tinnitus correlate?** Munguia R., Pienkowski M., Eggermont JJ.
P9.	**Hints for motor cortex excitability as biomarker for neuroplasticity in tinnitus** Schecklmann M., Lehner A., Kreuzer P.M., Poeppl T.B., Landgrebe M., Langguth B.
P10.	**Management of the fluctuating tinnitus.** Soraya Hoover
	Auditory and Cognitive Sciences
P11.	**Temporomandibular joint disorder, headache, and neck pain: hints for putative tinnitus subtypes** Schecklmann M.,Lehner A.,Kreuzer P.M.,Poeppl T.B., Vielsmeier V., Landgrebe M., Langguth B.
P12.	**Prevalence and characteristics of tinnitus after noise exposure during recreational activities** Degeest S., Corthals P., Vinck B., Keppler H.
P14.	**Efficacy of Ear Plug have to evaluate with Real Ear Plugged Response** Nakagawa.M.
P15.	**An evaluation of the content and quality of tinnitus information on websites preferred by general practitioners** Fackrell K., Hoare D.J., Smith S., McCormack A., Hall D.A.
P16.	**Posttraumatic Tinnitus: a TRI Database Evaluation** Kreuzer, P.
P17.	**Cognitive speed as an objective measure of tinnitus** Das S.K., Wineland A.M., Kallogjeri D., Piccirillo J.F.
P18.	**Validation of the chinese mini tinnitus questionnaire** Kam A.C.S., Tong M.C.F., van Hasselt C.A.
P19.	**A study of prognotic factors for tinnitus retraining therapy by using a multivariate analysis** Sakashita T., Kato S., and Yamane H.
P20.	**Tinnitus: Distinguishing Between Subjectively Perceived Loudness and Tinnitus-Related Distress** Wallhäusser-Franke E., Balkenhol T., Delb W.
P21.	**Genetics of family members with Tinnitus** Cacace A.T., Knipper M., Bolz H.
P22.	**The prevalence of tinnitus in children in Poland** Raj-Koziak D., Skarżyński H., Kochanek K., Bartnik G., Fabijańska A.
P23.	**Tinnitus in school age** Guimarães T.G., Leite-Barros P.A.M., Mota L.A.A., Pimentel G.A.
P24.	**Residual Hearing Area Quantification (RHAQ) in Cochlear Implant users suffering from Partial Deafness**

	Mertens G., Anderson I., Kleine Punte A., De Bodt M. and Van de Heyning P.
	Treatment
P25.	**Neuroscience and psychoanalysis on tinnitus research** Vergara R.
P26.	**Reduction of Tinnitus Severity by the Centrally Acting Muscle Relaxant Cyclobenzaprine: An Open-Label Pilot Study** Coelho C.
P27.	**Internet-based sound therapy (IBST) for tinnitus** Bergholm M., Lehtimäki J., Sariola J., Ylikoski M., Pirvola U., Ylikoski J.
P28.	**Effect of Different Sounds on the Treatment Outcome of Tinnitus Retraining Therapy** Suh Myung-Whan
P29.	**Transcranial direct current stimulation (tDCS) intensity and duration effects on Tinnitus suppression** Shekhawat G.S, Searchfield G.D.
P30.	**Multisite rTMS for the treatment of chronic tinnitus: stimulation of the cortical tinnitus network – a pilot study** Lehner A., Schecklmann M., Poeppl T. B., Kreuzer P. M., Vielsmeier V., Landgrebe M., Langguth B.
P31.	**Comparison of the Therapeutic Efficacy of One-on-One vs. Small-Group Counseling based on Modified Tinnitus Retraining Therapy** Shi-Nae Park, Seong-Cheon Bae, Dong-Kee Kim, Kyoung-Ho Park, Sang-Won Yeo.
P32.	**Multicentric study in slight hipoacusias, disabling Tinnitus and integral therapy of tinnitus** Moreno Vidal C., Hernando Leal M.V., Fernández Chávez M.A., Ibeas Franco L., Antón Canales A., Jimeno Brabo C., Serna Peinado P., Lopez Marquez M.M., Gonzalez Garcia D., Toledano Quintana A., Olivares Checa M., Martinez Mintegui D., Starczewska Navarro P., Pérez Duarte U., García Cabrera V.
P33.	**Effectiveness of bilateral repetitive trancranial magnetic stimulation in patients with chronic tinnitus** Hoekstra C.E.L., Versnel H., Neggers S.F.W., Niesten M.E.F., Van Zanten G.A.
P34.	**Prognostic models for changes in tinnitus handicap after cochlear implantation** Kloostra F.J.J., Arnold R., Van Dijk P.
P35.	**Acoustic CR neuromodulation counteracts imbalance of causal interactions of brain areas in patients with subjective chronic tonal tinniuts** Silchenko A. N., Adamchic I., Hauptmann C., Tass P.A.
P36.	**Suppression of tinnitus in a patient with unilateral sudden hearing loss: case-report** Fioretti A., Peri G., Eibenstein A.
P37.	**Computational analysis of long-lasitng desynchonization by electrical and sensory coordinated reset neuromodulation** Popovych O.V. and Tass P.A.
P38.	**Transcranial direct current stimulation (tDCS) induces short- and long-lasting of improvement of tinnitus intensity and discomfort: evidences from additional recruitment** Garin P., Gilain C., Van Damme J-P., de Fays K., Jamart J., Ossemann M., Laloux P., Vandermeeren Y.
P39.	**Palatal muscle resection for intractable palatal myoclonus causing tinnitus** Heo K.W., Jung H., Kim J.R.
P40.	**Autologous cartilage injection for the patulous Eustachian tube** Kong S.K., Lee I.W., Goh E.K., Lee H.J.
P41.	**Effects of Memantine on Chronic Tinnitus induced By Acoustic Trauma In Rats** Zheng Y., McNamara E., Stiles L., Darlington C.L., Smith P.F
P42.	**Antioxidant treatment in noise-induced tinnitus: A literature review and study preparation** Gilles A., Peeters J., Ihtijarevic B., Rabau S., Kleine Punte A., De Ridder D., Van de Heyning P.
P43.	**Tinnitus affects what and where processing** Park C., Searchfield G.D.
P44.	**Correlation type of masker noise of the minimum masking level and Tinnitus Questionnaire in chronic tinnitus patients** Rabau S., Waelkens B., Wouters K., Cox T., Janssens de Varebeke S., Van de Heyning P.
P45.	**Effects of frequency discrimination training on tinnitus: results from a series of randomized trials** Hoare D.J., Kowalkowski V.L., Hall D.A.
P46.	**No effect of tinnitus intensity and distress on speech in noise results in single-sided dea patients** Desmet J., Kleine Punte A., de Bodt M. and Van de Heyning P.

P47.	**Results of otoacoustic emissions and efferent suppression in subjects with chronic tinnitus after noise exposure during recreational activities** Keppler H., Corthals P., Vinck B., Degeest S.
P48.	**Combining "TAILOR-MADE NOTCHED MUSIC TRAINING (TMNMT)" with left auditory cortex tDCS: an explorative study** Teismann H., Wollbrink A., Okamoto H., Pantev C.
P49.	**Tinnitus and normal hearing - a study of 175 cases.** Fabijańska A., Smurzyński J., Kochanek K., Raj-Koziak D., Bartnik G., Skarżyński H.
P50.	**Spatial & temporal perception** An Y.H., Oh S.H., Choi B.H., Koo J.W., Song J.J., Shim H.J.
P52.	**Nanotheranostics: application to Tinnitus research** Cacace A.T., Holt A.G., Castracane J., Bergkvist M.
	Functional Imaging
P53.	**Lessons from two-ALE meta-analyses of PET studies on tinnitus and cochlear implant** Song J.J., Vanneste S., Van de Heyning P., Jeong Hun Jang, De Ridder D.
P54.	**Changes of oscillatory activity in the tinnitus network and related tinnitus relief induced by CR neuromodulation** Adamchic I., Hauptmann C., Toth T., Tass P.A.
P55.	**Deceased evoked brain activity in left auditory cortex of tinnitus subjects durin attentional task performance** Amaral A.I.A., Langers D.R.M.
P56.	**Inverse correlation of tinnitus loudness and hearing impairment with gamma-band power** Balkenhol T., Wallhäusser-Franke E., Delb W.
P57.	**An fMRI study of emotional processing in tinnitus using affective sounds** Husain F.T.
P58.	**Central activity in a young tinnitus population: A qEEG analysis** Gilles A., Vanneste S., De Ridder D., Van de Heyning P.
P59.	**Factors affecting electrophysiological correlates of tinnitus** Bosnyak D.J., Bruce I.C., and Roberts, L.E.

Abstracts

WEDNESDAY
JUNE 13, 2012

08:00 - 09:00 p.m.
OPENINGS SPEAKER

ACADEMIC FREEDOM: SEPARATION FROM RELIGION AND STATE?

Rik Torfs
Rik Torfs is professor of Canon Law at the Catholic University of Louvain, Belgium, journalist, media figure and senator. As an academic and politician he is ideally placed to give the opening lecture on science, risks and society. His opening lecture will bring us back to one of the driving questions of the TRI ? Should society, TRI and other players involved in scientific research combine explorative and solidifying approaches, or should society limit risky scientific research?

Academic freedom is a highly discussed issue in our days. It is always in danger. Yet the enemies differ. Who are they? Churches, large companies, bureaucrats, politicians, emancipation movements all qualify. Let us look for deeper causes and lasting solutions.

THURSDAY
JUNE 14, 2012

9:00 - 10:15 a.m.
PLENARY TALKS

9:00 - 9:45 a.m. – Keynote Speaker
TINNITUS: FROM COCHLEA TO CORTEX

Paul Van de Heyning
Paul Van de Heyning is an ENT Professor at the University Hospital Antwerp, Belgium and Dean of the faculty of Medicine at the Antwerp University. He published more than 300 articles mainly on tinnitus and hearing and is an international expert on Cochlear implants and its influence on phantom sounds in tinnitus patients. Paul Van de Heyninig is co-director of the Brain Research center Antwerp for Innovative and Interdisciplinary Neuromodulation (BRAI^{2}N) and TRI tinnitus clinic Antwerp.

Tinnitus is the auditory perception of the sound or sounds that do not correspond with sounds in the surrounding of the patient. It consists of two processes. The first is the bottom-up process in the auditory system in which the cochlea is the main input. A second process is a top-down process which is neurocognitive in nature and controls the awareness of the sound percept. Both processes do not only involve the auditory system responsible for tinnitus loudness but also the extra auditory central nervous system, generally involved in tinnitus distress. The complex nature of these interactions has become clear by the evidence that auditory and non-auditory processes are network activities between different parts of the brain. Investigations have to disentangle the different components of these networks and their interplay. Future therapies have to target the individually main driving physiopathological processes, which often will have actions aswell on the bottom-up as on top-down processes. Whereas at the beginning purely audiological an auditory treatments often failed and neither mere neurophysiological approaches could cure the tinnitus percept, current and future translational auditory neurocognitive approaches open the way to a better understanding of tinnitus and its auditory percept, and so the development of cures. However as were we stand today, we cannot emphasize enough the importance of using noise protective measures by youngsters and older people during loud music events or noisy activities.

9:45 - 10:15 a.m. – Invited Speaker
VERTIGO AS A VESTIBULAR PHANTOM PERCEPT

Floris Wuyts
Floris Wuyts is professor of biomedical physics, and Head of AUREA (Antwerp University Research centre for Equilibrium and Aerospace), and visiting professor at the University of Ghent, Belgium, and University College, UK. He has lectured widely (among those also for the NATO) and collaborates with both NASA and ESA. As an expert on vertigo, he will extend the well-known analogy between phantom pain and phantom sound to vertigo as a phantom equilibrium perception.

Vertigo is per definition the sensation of self-motion when no self-motion is occurring or the sensation of distorted self-motion during an otherwise normal head movement. With other words: “vertigo is the illusion of movement”. The vestibular system uses a multitude of information, coming from vision, proprioception, the vestibular organs, auditive cues etc, to build an internal model of ‘how we are oriented in space”. Any persistent conflict between this internal model and afferent signals from one of these sensors leads to motion sickness, with symptoms of vertigo, nausea, and eventually vomiting. Patients with a lesion in their inner ear caused by e.g. Meniere’s disease, labyrinthitis or Benign Paroxysmal Positional Vertigo suffer also from vertigo, but recently, “vestibular migraine” has been recognized as a very common cause of vertigo. Thus, vertigo can arise also purely at the level of the brain. Recent studies using PET, fMRI and methods such as Diffusion Tensor Imaging have revealed new insights in how vestibular information is being processed at cortical levels. During this talk, the author will present the latest insights in how misinterpreted motion can lead to vertigo.

10:45 a.m. - 12:45 p.m.

SESSION 1: Treatment
Chair: Claudia Coelho

Room: Morus

CLONAZEPAM QUIETS TINNITUS: A RANDOMIZED CROSSOVER STUDY WITH GINKGO BILOBA

Nam E.C., Han S.S., Won J.Y., Lee K.U., Chun W., Choi H.K., Levine R.A.

[1] Kangwon National University, School of Medicine, Department of Otolaryngology, Institute of Medical Science, Chuncheon, Republic of Korea; [2] Kangwon National University, School of Medicine, Department of Internal Medicine, Institute of Medical Science, Chuncheon, Republic of Korea; [3] Kangwon National University, School of Medicine, Department of Psychiatry, Chuncheon, Republic of Korea; [4] Kangwon National University, School of Medicine, Department of Pharmacology, Institute of Medical Science, Chuncheon, Republic of Korea; [5] Harvard Medical School, Departments of Otolaryngology and Neurology, Boston, USA

Background: A recent review stated that no drugs provide replicable long-term reduction of tinnitus impact. However, two well-designed studies using the short-acting benzodiazepine, alprazolam, found a significant quieting of tinnitus using a visual analog scale (VAS). No well-designed studies have assessed the impact upon tinnitus of long-acting benzodiazepines.

Materials and Methods: Open-label, randomized, crossover study of 38 adults (27 M, 11 F) with tinnitus for more than 2 months randomized to either clonazepam or ginkgo for the first 3 weeks. For the next 2 weeks no medication was taken. For the final 3 weeks, subjects received the other drug. The initial dose was one tablet daily (clonazepam 0.5 mg; ginkgo 40 mg). Subjects increased the dose by one tablet every 3 days to a maximum of 4 tablets hs until a satisfactory decrease in tinnitus loudness or intolerable side effects occurred. Tinnitus was assessed with pitch- and loudness-matching, tinnitus handicap inventory (THI), and VAS of loudness, duration, and annoyance.

Results: Comparing before and after, clonazepam significantly improved tinnitus loudness (74% of subjects), duration (63%), annoyance (79%), and THI score (61%), whereas ginkgo showed no significant differences for any of these measures. Three subjects heard no tinnitus with clonazepam, zero with ginkgo.

Conclusion: This third well-designed study establishes benzodiazepines as a drug class that can significantly quiet tinnitus. As a long-acting medication, clonazepam is preferable to alprazolam, because long half-life medications have less withdrawal issues and better compliance due to once a day dosing.

EFFECTS OF L-BACLOFEN ON CHRONIC TINNITUS INDUCED BY ACOUSTIC TRAUMA IN RATS

Smith P.F., Vagal S., McNamara E., Darlington C.L., Zheng Y.

Department of Pharmacology and Toxicology, School of Medical Sciences, University of Otago Medical School, and the Brain Health Research Centre, University of Otago, Dunedin, New Zealand.

Background: Neurophysiological studies suggest that tinnitus is associated with neuronal hyperactivity in auditory brain regions. Consequently, one avenue for drug therapy has been the use of anti-epileptic and anti-spasticity drugs. One such drug is the anti-spasticity agent, baclofen, although the clinical evidence supporting its efficacy has been unconvincing to date. The aim of this study was to investigate the effects of L-baclofen in an animal model of noise-induced tinnitus.

Materials and Methods: Sixteen male Wistar rats were divided into acoustic trauma (n = 8) and sham control (n = 8) groups. The acoustic trauma consisted of a 16 kHz, 110 dB pure tone delivered unilaterally for 1 h under anaesthesia. Auditory function was assessed using auditory brainstem-evoked response (ABR) thresholds. The behavioural signs of tinnitus were measured by a conditioned lick suppression paradigm at 2 weeks after acoustic trauma and during the drug treatment period. L-baclofen, the more active isomer of baclofen, at 1, 3 or 5 mg/kg s.c doses, or its vehicle, was administered 1 h before testing.

Results: Acoustic trauma resulted in a significant increase in ABR thresholds at 8, 16 and 20 kHz ($P < 0.008$). It also resulted in a significant decrease in the suppression ratio (SR) compared to sham controls in response to 20 kHz tones, but not broadband noise or 10 kHz tones, in pre-drug and vehicle control testing ($P < 0.002$). For the 3 and 5 mg/kg doses, L-baclofen significantly reversed the frequency-specific decrease in the SR in the acoustic trauma group.

Conclusion: The more active isomer of baclofen, L-baclofen, may reduce tinnitus caused by acoustic trauma.

ZINC TO TREAT TINNITUS IN THE ELDERLY: A RANDOMIZED PLACEBO CONTROLLED CROSSOVER TRIAL

Coelho C., Witt S., Ji H., Marlan Hansen, M., Gantz B. J., Tyler R.

Several reports suggest that zinc, which is involved in several neural transmissions systems throughout the auditory pathway, might help some tinnitus patients. However, prior studies used inadequate experimental designs. Therefore, we tested the effectiveness of zinc to reduce tinnitus in a randomized placebo controlled design. We focused on subjects over 60 years of age, who are more likely to have a zinc deficiency. In phase 1, 58 subjects were randomized to receive 50mg of zinc/ day for 4 months and 58 subjects received a placebo. After a 1 month washout period, the two groups were crossed over to receive the alternative regime. Pre and post measures were made of the Tinnitus Handicap Questionnaire and tinnitus loudness and annoyance (0-100% scales). 5 of 93 (5.4%) subjects showed a significance decrease in the tinnitus Handicap Questionnaire during zinc treatment compared to 2 of 94 (2.1%) during placebo treatment. 5 of 93 (5.4%) subjects showed a significance decrease in the tinnitus Handicap Questionnaire during zinc treatment compared to 2 of 94 (2.1%) during placebo treatment. 6 of 93 (5.1%) subjects showed a significance decrease in loudness during zinc treatment compared to 3 of 93 (3.2%) during placebo treatment. 4 of 93 (4.3%) subjects showed a significance decrease in annoyance during zinc treatment compared to 4 of 93 (4.3% during placebo treatment). The group analysis showed increment following zinc treatment of 22.0 to 23.7 points on the questionnaire, of 67.8 to 68.1 on loudness rating and of 59.7 to 61 on annoyance rating, none of which were statistically significant.

THE EFFECT OF NALTREXONE ON THE PERCEPTION AND DISTRESS IN TINNITUS: AN OPEN LABEL PILOT STUDY

Andréia Azevedo[1], Sven Vanneste[2,3], & Dirk De Ridder[2]
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[2] *Brai²n, Tinnitus Research Initiative Clinic Antwerp & Department of Neurosurgery, University Hospital Antwerp, Belgium*
[3] *Department of Translational Neuroscience, Faculty of Medicine, University of Antwerp, Belgium*

Tinnitus is a perceived sensation of sound without actual acoustic stimulation. Currently there are no standardized drug therapies for the treatment of tinnitus patients. A potential novel treatment for chronic tinnitus is naltrexone. Tinnitus can be considered an auditory phantom phenomenon similar to phantom pain. Excitatory opioid responses are selectively blocked by low doses of naltrexone while inhibitory responses are not as such having an analgesic effect. However, tinnitus can also be induced by apoptosis of neuronal tissue within the auditory pathway. Recent studies showed that high doses of naltrexone have a neuroprotective effect via modulation of mitochondrial apoptotic pathways. This implicates a protective role for the opioid antagonist against injurious stimuli activating the death receptor-linked apoptotic pathway. The aim of the present study is to investigate three doses of naltrexone, namely 5, 12.5 and 50 mg and determine their influence on tinnitus complaints. We conducted a four weeks single-center, single-arm, open-label treatment study. Eighty-six patients received the drug treatment, while 30 patients received no treatment. Overall tinnitus distress was significantly reduced for the drug treatment group, while for the waiting control group this was not the case. No significant effect could be obtained for tinnitus intensity. A closer look at the data indicates that this effect is mainly generated due to a significant difference in the 50 mg drug treatment group for tinnitus distress.

PREVENTING THE EMERGENCE OF TINNITUS POST-TRAUMA WITH DRUG-LOADED NANOPARTICLES

Didier Depireux
University of Maryland College Park, Institute for Systems Research

Following noise trauma, treatment of injury and inflammation of the cochlea is essentially dependent on the ability to deliver drugs to the inner ear structures. To this end, nanoparticles are a natural candidate because of their biocompatibility, the ability to load them with a variety of drugs, and the promise they can deliver their payloads without causing additional injury or trauma to the inner ear. We have used superparamagnetic nanoparticles with a maghemite core, coated with a chitosan and loaded with fluorescent proteins for visualization. We measured the penetration of the cochlear space by these particles as a function of the particles' diameter, external field strength and duration of exposure to the external magnetic field while the particles are being actively steered by a configuration of magnets, both pulling from the contralateral side of the skull and pushing from the ipsilateral side. We also demonstrated their elimination through the lymphatic system, starting within days of administration. We are testing the effectiveness of magnetically pushed nanoparticles functionalized with prednisolone on preventing the emergence of tinnitus in a rat model of noise-trauma induced tinnitus, and we will report on this new method of drug delivery, how much reduction of tinnitus we obtain, and possible future developments.

Efficacy and safety of AM-101 in the treatment of acute inner ear tinnitus – A Double Blind, Randomised, Placebo Controlled Phase II Study

EFFICACY AND SAFETY OF AM-101 IN THE TREATMENT OF ACUTE INNER EAR TINNITUS – A DOUBLE BLIND, RANDOMISED, PLACEBO CONTROLLED PHASE II STUDY

Van de Heyning P.[1], Cox T.[2], Maier H.[3], Muehlmeier G.[3], Morawski K.[4], Lisowska G.[5], Meyer T.[6]
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2 Dept. of ENT, Head and Neck Surgery, Virga Jesse Hospital, Hasselt, Belgium;
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4 Dept. of Otolaryngology, Medical University of Warsaw, Warsaw, Poland; 5Private ENT practice, Tarnowskie Góry, Poland;
6 Auris Medical AG, Basel, Switzerland

Glutamate excitotoxicity following cochlear insult may trigger aberrant excitation of the auditory nerve, which is perceived as tinnitus. AM-101, a small molecule NMDA receptor antagonist, is currently being developed for the intratympanic treatment of acute inner ear tinnitus. Following positive outcomes from a previous study, a phase II trial aimed to evaluate AM-101's efficacy and safety in a larger number of patients. In a double blind, randomised, placebo controlled study a total of 248 subjects with persistent tinnitus no older than three months from acute noise trauma, otitis media or sudden deafness were enrolled. They received three i.t. injections of AM-101 270 µg/mL, AM-101 810 µg/mL or placebo over three consecutive days. Study subjects returned for follow-up on Days 7, 30 and 90. The primary efficacy endpoint was the change in MML to Day 90; changes in tinnitus loudness and annoyance were co-primary efficacy endpoints. Secondary efficacy outcome variables included: sleep impact scores, TBF-12 questionnaire, loudness match and patient global impression of change. Safety was evaluated by the frequency of clinically relevant changes in hearing and of adverse events. The study overall failed to meet its primary efficacy endpoint as no significant differences in the change of MML were observed between treatment groups. However, AM-101 810 µg/mL showed substantial and statistically significantly better reductions in tinnitus loudness, sleep impact and tinnitus impairment in patients suffering from acute tinnitus with established cochlear origin than placebo. In contrast, the subgroup of sudden deafness related tinnitus did not show conclusive results. The study drug as well as i.t. injections were well tolerated. The study established proof of concept in man for AM-101 in the treatment of tinnitus arising from cochlear glutamate excitotoxicity. It confirmed the importance of careful definition and selection of target treatment groups and the choice of appropriate outcome variables. Psychoacoustic measures, despite their appeal as "semi-objective" measure, do not seem to be sufficiently reliable for efficacy assessments.

10:45 a.m. - 12:45 p.m.
SESSION 2:
Auditory & Cognitive Changes
Chair: Sylvie Herbert
Room: Erasmus

CLINICAL CHARACTERISTICS AND THERAPEUTIC RESPONSE OF OBJECTIVE TINNITUS DUE TO MIDDLE EAR MYOCLONUS: A LARGE CASE SERIES

Shi-Nae Park, Seong-Cheon Bae, Kyoung-Ho Park, Sang-Won Yeo.
Department of Otolaryngology-HNS, Seoul St. Mary's Hospital, The Catholic University of Korea, College of Medicine, Seoul, Korea

Objectives: To evaluate the clinical characteristics and therapeutic response of tinnitus due to middle ear myoclonus (MEM) and to suggest appropriate diagnostic methods.

Method: This study included 58 patients with tinnitus diagnosed with MEM, who were seen from January 2004 to July 2011. Clinical and audiological characteristics were investigated. The therapeutic responses to counseling, medical therapy, and surgical therapy were evaluated.

Results: Patients had a mean age of 29.8 (range 6–70) years: 20.7% (n=12) were <10 years, 39.7% (n=23) were <20 years, 74.1% (n=43) were <40 years, and 5.2% (n=3) were ≥60 years. Remembered stressful events and noise exposure were associated with the onset of MEM in 51.8% (n=30) and 27.6% (n=16) of patients, respectively. The most frequent nature of the tinnitus was a crackling sound. MEM associated with forceful eyelid closure was observed in 15% of patients. Impedance audiogram and otoendoscopic examinations of the tympanic membrane were helpful tools for diagnosing MEM. With medical therapy, more than 75% of patients exhibited complete or partial remission of their tinnitus. Patients with intractable MEM who underwent sectioning of the middle ear tendons had very good outcomes.

Conclusion: Tinnitus due to middle ear myoclonus seems to occur in young patients and to be related to stress or noise. Information about the clinical characteristics and therapeutic response of this less-common type of tinnitus will be helpful for its early and appropriate diagnosis and treatment.

THE INCIDENCE OF DISABLING TINNITUS: A POPULATION-LEVEL UK COHORT STUDY

Hall D.A.[1], Wallenhorst C.[2], Martinez C.[3]
[1] *NIHR National Biomedical Research Unit in Hearing (NBRUH), University of Nottingham, UK*
[2] *Mathematician, Frankfurt, Germany*
[3] *Consultant epidemiologist, Frankfurt, Germany*

Introduction: Long-term incidence studies are particularly valuable for identifying factors associated with tinnitus development. Nevertheless, prospective incidence studies are costly to run and only two major studies have so far been reported (Beaver Dam, Wisconsin, US and Blue Mountains Hearing Study, Sydney, Australia).

Aim: To estimate the incidence rate of 'disabling tinnitus' (DT) that burdens the UK National Health Service.

Patients and Methods: The source population was the subset of general practices in the UK contributing primary care data to the General Practice Research Database (GPRD). We identified all patients with DT (01 January 2001 to 31 December 2011). DT was defined as the first recording (index day) of tinnitus symptoms by the general practitioner which led to follow-up examinations or specific treatment (at both primary and secondary care levels) within 28 days. Among 44.6 million person-years of observation in the 11-year period, we identified 23,672 incident cases of DT. Overall incidence rate of DT was 5.3 per 10,000 person-years, increasing from 3.9 (2001) to 6.6 (2011). It increased with age and was highest in the 60-69 age group (12.5 in men and 10.8 in women, per 10,000 person-years). Of the total, 7.2% had a previous diagnosis of Ménière's disease or vestibular disorder, 17.2% of hearing loss, 25.3% of 'non-disabling' tinnitus (i.e. not meeting the DT criteria) and 0.1% of acoustic neuroma. Our population-level findings for DT confirm and extend previous research conducted in regional cohort groups.

RISK FACTORS FOR DEVELOPING A DISABLING TINNITUS: A POPULAITON-LEVEL UK COHORT STUDY

Wallenhorst C.[1], Martinez C.[2], Hall D.A.[3]
[1] *Mathematician, Frankfurt, Germany*
[2] *Consultant epidemiologist, Frankfurt, Germany*
[3] *NIHR National Biomedical Research Unit in Hearing (NBRUH), University of Nottingham, UK*

Introduction: Baseline factors associated with the risk of tinnitus can inform the more efficient allocation of public health resources or target prevention campaigns.

Aim: Identify risk factors for developing a 'disabling tinnitus' (DT).

Patients and methods: The source population was the General Practice Research Database (GPRD), a primary care database in the UK. From January 2001 to December 2011, all patients with first-time DT with no prior recording of hearing loss or 'non-disabling tinnitus' and a control cohort free of hearing loss and tinnitus (disabling or non-disabling) were identified. The control cohort was matched on each DT case's year of birth, gender, date of first DT diagnosis (index day) and general practice. In a case-control analysis, adjusted odds ratios (ORs) were estimated using conditional logistic regression for potential risk factors discussed in the literature. We also included the factors smoking, drinking, BMI and socioeconomic status. ORs with 95% confidence intervals (CI) were provided for risk factors present in the 90 days, 182 days or recorded any time before the index day.

Results: We found 14,648 cases of DT and 53,958 matched controls. Adjusted ORs were increased for ear infections within 90 days (OR: 10.08; CI: 8.18-12.43), Ménière's disease/vestibular disorders within 182 days (9.32; 7.32-11.87), otosclerosis (3.84; 1.87-7.92), acoustic neuroma (3.78; 1.59-8.97), head injury within 90 days (3.73; 1.75-7.96), obsessive compulsive disorders (1.65; 1.19-2.28) and rheumatological conditions (1.44; 1.37-1.50).

Conclusion: This study confirms established risk factors (head injury), and other factors previously discussed (ear infections, vestibular disorders and rheumatological conditions).

CLINICAL EVALUATION OF A COMPUTERIZED SELF-ADMINISTERED TINNITUS MEASUREMENT SYSTEM

Kam A.C.S.[1,2], Sung J.K.K.[1,2], Lee T.[3], Wong T.K.C.[1,2], van Hasselt C.A.[1,2]

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[2] *Institute of Human Communicative Research, Chinese University of Hong Kong, Hong Kong;*
[3] *Department of Electronic Engineering, Chinese University of Hong Kong, Hong Kong*

Introduction: The basic step in most tinnitus management programs is to quantify the characteristics, including pitch and loudness, of the perceived tinnitus. The success of some contemporary tinnitus management approaches, such as tinnitus notched therapy, relies on the accuracy of the tinnitus pitch matched. Our research team developed a self-administered tinnitus measurement system which is capable to measure tinnitus frequency in one hertz resolution via a smartphone.

Aim: To investigate the feasibility and accuracy of the self-administered tinnitus measurement system.

Materials and Methods: Twenty patients with subjective tinnitus were recruited in the Audiology clinic in a hospital setting. The subjects completed the conventional procedures or the automated tinnitus measurement in a randomized order. Subjects were asked to rate on a 100-point visual analog scale on the similarity of the measured tinnitus tone and loudness and the one perceived. Tinnitus pitch and loudness obtained with both methods were compared. Test-retest reliability of both methods was investigated.

Results: There was no significant difference in the thresholds of unmasked air-conduction hearing obtained with the computerized self-administered hearing test via a smartphone and those obtained with standard pure-tone audiometry. Comparable variability was observed for within-session repeated tinnitus pitch and loudness measured via both conventional and the automated method. There was no significant difference in VAS rating on similarity between the measured and perceived tinnitus pitch and loudness for repeated measures in the same session.

Conclusion: It is feasible to perform tinnitus pitch and loudness measurement with the self-administered system via a smartphone.

IMPROVING TINNITUS PITCH MATCHING: IMPLICATIONS FOR NEUROPHYSIOLOGICAL MODELS AND CLINICAL PRACTICE

Fournier P.[1,2,3], Basile C-E. [1,2,3] Hutchins S.[2] & Hébert S. [1,2,3]

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[2] *CRBLM, Center of Research on Brain, Music and Language,*
[3] *CRIUGM, Centre de recherche Institut Universitaire de Gériatrie de Montréal*

Background: Psychoacoustical measurements of tinnitus have led to important neuroscientific models. However, conflicting data coexist, some supporting the notion that tinnitus consists of a single pitch whereas others support that tinnitus spectrum mirrors hearing loss. We tested the hypotheses that *i)* tinnitus may be characterized by either the prominent pitch within the hearing loss region (using a discrete frequency mode of presentation) or by a single pitch (using continuous pitch presentation) and *ii)* that musical experience improves tinnitus pitch-matching abilities.

Material and Methods: Musicians and non-musicians with high-frequency tinnitus participated in two tinnitus-matching tasks and were retested several weeks later. The Touchscreen task consisted in a wide range of discrete frequencies that participants had to rate for their likeness to their tinnitus pitch and loudness. The Slider task consisted of a continuous frequency presentation (in 1Hz steps) that participants had to match to their tinnitus by moving a slider.

Results: The two methods yielded highly concordant results. Mean likeness ratings for tinnitus followed a similar trend as for hearing loss, i.e., higher likeness ratings were ascribed to the frequency regions most affected by hearing loss in both groups. No significant differences in the predominant pitch were identified between the two methods. Moreover, musical experience did not improve tinnitus pitch matching.

Conclusions: Both participant-oriented methods replicated previous findings that the predominant tinnitus frequency usually lies within the hearing loss region, in accordance with the neural synchrony theory (versus tonotopic expansion).

PSYCHOACOUSTICS AND NEURAL CORRELATES OF GAZE-EVOKED TINNITUS

van Gendt M.J.[1], Boyen K.[1,2], de Kleine E.[1,2], van der Laan B.F.A.M.[1], Langers D.R.M.[1,2], van Dijk P. [1,2]

[1] *University of Groningen, University Medical Center Groningen, Department of Otorhinolaryngology / Head and Neck Surgery, The Netherlands*
[2] *Graduate School of Medical Sciences (Research School of Behavioural and Cognitive Neurosciences), University of Groningen, The Netherlands.*

Background: The goal of this study was to identify mechanisms that underlie gaze-evoked tinnitus (GET), the perception of a phantom sound that is elicited or modulated by eye movement.

Materials and Methods: GET was investigated in 18 subjects who underwent surgical removal of a tumour in the cerebellopontine angle. They all perceived tinnitus that was modulated or evoked with peripheral gaze. Nine normal-hearing control subjects were included. Psychoacoustics and functional magnetic resonance imaging (fMRI) were performed. The tinnitus percept and modulations were matched in loudness, pitch and bandwidth to a sound presented at the ear contralateral to the side of surgery. Functional MRI measurements were performed with sound stimuli and eye movement tasks.

Results: The gaze-evoked tinnitus changes were variable across subjects. Typically, the perceived modulations comprised increases in loudness and pitch and decreases in bandwidth. For gaze directions that yielded considerable loudness modulation of the tinnitus, region of interest analyses showed significantly more activation of the auditory cortices compared to gaze directions that yielded a minor or no increase in tinnitus loudness. Moreover, the perception of an increased tinnitus loudness tended to coincide with increased activation in the inferior colliculi and the basal ganglia.

Conclusions: These results show that gaze evoked tinnitus loudness is represented by neural activity in auditory cortical areas and tends to be correlated with neural activity in non-auditory areas as well, suggesting a failure of cross-modal inhibition and sustained hyperactivity related to the tinnitus.

1:45 - 3:00 p.m.
PLENARY TALKS

1:45 - 2:30 p.m. – Keynote Speaker
AUDITORY ALPHA: FROM CLINICAL TO COGNITIVE NEUROSCIENCE AND BACK

Nathan Weisz
Nathan Weisz is one of the leading tinnitus researchers in the world, moving from the University of Konstanz in Germany to the University of Trente, Italy. He was awarded a large grant by the European Research Council in 2011, permitting him to set up a new laboratory. The scientific mission of Nathan's research group is to advance the understanding of the functional relevance of spontaneous brain oscillations. Besides fundamental experiments with healthy participants, his approach includes the investigation of abnormal brain rhythms in pathologies like tinnitus and their relationship with behavioral symptoms. In order to pursue these goals he uses MEG, EEG, TMS and behavioral experiments. He will talk about the relevance of spontaneous brain activity and functional connectivity for understanding the pathophysiology of tinnitus.

Alpha oscillations are an omnipresent feature of ongoing brain activity. Initially thought to reflect an "idling" state, current cognitive neuroscientific research indicate strong alpha to represent a state of relative inhibition. While these notions have been mainly gained from studies in the visual as well as sensorimotor systems, works in the auditory modality have been scarce. Based on our initial findings of reduced alpha activity in tinnitus patients, I will in this talk review some of the current cognitive neuroscientic works from my lab indicating that alphalike oscillations in the auditory system play a similar functional role as in other sensory systems. More specifically I will present data showing their relationship to (normal) auditory phantom percepts as well as attention. My main argument will be that with regards to tinnitus, reduced auditory alpha activity may constitute a useful proxy for the assumed excitatory-inhibitory imbalance that has been suggested for this condition and that one useful avenue for treatment of chronic tinnitus may lie in selectively enhancing auditory cortical alpha. At the end of my presentation I will review some of our attempts with respect to this goal.

2:30 - 3:00 p.m. – Invited Speaker
A TECHNOLOGY PUSH FOR ELECTRICAL NEUROMODULATION

Wouter Serdijn
Wouter Serdijn is Associate Professor at the faculty of Information Technology and Systems (now Electrical Engineering, Mathematics and Computer Science) at the Technical University of Delft, in The Netherlands.. He is also Editor-in-Chief of IEEE Transactions on Circuits and Systems. His research as an electrical engineer focuses on cochlear implants and brain stimulators, and his team is developing both invasive and non-invasive technology for the treatment of tinnitus. His talk will focus on these technologies and how engineers and clinicians can collaborate to fight tinnitus.

Due to favorable results from actual monitoring, treatment and clinical trials, but equally important, due to advances in microelectronics, wireless communications, batteries, bio-compatible materials and software, the potential clinical value of electronic neuromodulators for the treatment of brain related disorders such as tinnitus is gradually being recognized. Yet, despite the miracles they can bring, current devices are severely limited in functionality and performance. In the Biomedical Electronics group at Delft University of Technology we try to push the technology for wearable and implantable devices, such as cochlear implants and neurostimulators. This talk will address some of the shortcomings of existing cochlear implants and neurostimulators and sketch an avenue for the development of future devices that, e.g., do not suffer from "the wiring problem", that offer energy-efficient stimulation, readout of evoked compound action potentials, closed-loop operation and allow the patient to exercise various electrical stimulation patterns by means of a smart phone.

1:45 - 2:30 p.m. – Keynote Speaker
VIRTUAL REALITY (VR) IN SUBJECTIVE TINNITUS MANAGEMENT

Alain Londero
Alain Londero is a well-known ENT surgeon and artist living in Paris, France. As one of the leaders in the French tinnitus field he works in the hôpital Georges Pompidou de Paris, where he has been involved in all aspects of tinnitus treatments, from audiological approaches, to cognitive behavior therapy, but also including brain stimulation techniques as well as the development of virtual reality to treating tinnitus. His tinnitus related work and artistic expressions fuse in this virtual reality world but also in some of his paintings, where he often uses cochlear structures as inspiration for beautiful pictural creations.

Subjective Tinnitus (ST) is a phantom auditory percept frequently triggered by a loss in auditory input inducing maladaptive neuroplastic efforts within brain circuitries to compensate such a deficit. Perceptually, ST could be described as the emergence of an auditory form resulting from a negative figure/ground contrast between normally and abnormally processed frequencies, in other words the illusory perception of "missing information" during the auditory scene analysis. The correlation between ST features and hearing-loss laterality or spectrum supports this theory. Moreover clinical patterns and therapeutic management of ST are quite similar to those displayed in chronic pain following amputation, another example of "missing information" condition. As conditioning techniques using Virtual Reality (VR) have been shown to be both theoretically interesting and effectively useful in amputated patients, we have developed an innovative set-up with dedicated auditory and visual 3D VR environments. In this set-up, unilateral subjective tinnitus sufferers are given the possibility to voluntarily manipulate an auditory and visual image of their ST (tinnitus avatar). The main aim of such a technique is to give the patients the ability to transfer their subjective auditory perception to the tinnitus avatar, allowing them to take control and gain agency on this multi-sensory displayed percept. We have conducted a randomized clinical trial in a series of 131 patients. Following this trial, VR is well accepted as patients managed to immerse themselves in VR environments. Overall results indicate that VR is able to significantly improve tinnitus intrusiveness versus waiting list (THI p=.025, STSS p=.047).

04:00 - 05:30 p.m.

SESSION 3: Pathophysiology
Chair: Susan Shore

Room: Morus

NOISE-INDUCED TINNITUS: SELECTED NEUROBIOCHEMICAL, ANATOMICAL, AND PSYCHOMTRIC CHANGES FOLLOWING RTMS INCLUDING OTHER METABOLIC-RELATED EFFECTS

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Background: Repetitive transcranial magnetic stimulation (rTMS) is an experimental procedure showing positive effects in suppressing tinnitus. Yet, mechanisms-of-action are not well understood. Moreover, because a large percentage of adults with tinnitus also have hyperinsulinemia, metabolic issues and synergic effects with hearing loss is an area-of-interest. Thus, understanding the relationships between neurobiochemical, anatomical, psychometric, and metabolic variables are challenges requiring resolution to advance the field.

Materials and Methods: Using a single-blinded sham-controlled crossover design, Experiment 1 examined if rTMS affects tinnitus and whether it alters brain chemistry, brain anatomy, self perceived changes in questionnaire responses, and loudness levels following 5 sequential days-of-stimulation. Twenty-five adults, 24-80 years with a history of tinnitus and noise induced hearing loss participated. rTMS was applied to the temporal lobe of the left hemisphere (110% above motor threshold of the thumb-abductor muscle, at 1-Hz, pulse duration ~400 μs). In Experiment 2, we evaluated the relationship between Type-2 diabetes and tinnitus, based on a single-subject design. Blood-glucose levels, blood-pressure, self perceived questionnaire scores, and tinnitus-loudness levels were assessed twice per day, over a contiguous 30-day period.

Results: Neurobiochemical and psychometric changes were associated with pre-post actual rTMS. Most notably, glutamate was down regulated and loudness levels decreased under these conditions. Significant differences between blood-glucose levels and tinnitus-loudness levels were observed in PM vs. AM time periods; other significant relationships were also observed.

Conclusions: rTMS significantly altered neurobiochemical and psychometric factors related to tinnitus. Time-of-day effects of blood-glucose levels, psychometric correlates, and other effects observed in Type-2 diabetes may be associated with tinnitus-related distress.

GABA SIGNALING COMPONENTS IN THE MGB AND HIPPOCAMPUS OF RATS WITH CHRONIC TINNITUS

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[2] *Illinois College, Dept. of Psychology, Jacksonville, IL, USA;*
[3] *Southern Illinois University School of Medicine, Springfield, IL, USA*

Background: Animal models have facilitated significant research into the biological mechanisms underlying tinnitus. Initially, the spontaneous neural activity associated with tinnitus relies on afferent input from the cochlea. However, over time, the spontaneous activity is "centralized" and becomes somewhat independent of the peripheral input. Interestingly, numerous studies have suggested that both the auditory and limbic systems are involved in the centralization that corresponds to the transition from temporary to chronic tinnitus. Although multiple mechanisms likely play a role in the etiology of chronic tinnitus, increasing evidence suggests inhibitory γ-amino butyric acid (GABA) signaling may be altered in chronic tinnitus.

Materials and Methods: We used intense unilateral noise exposure to induce tinnitus in rats. We used the gap prepulse inhibition of the acoustic startle (GPIAS) to identify animals with chronic tinnitus-like behavior. We collected and extracted RNA from brain samples from auditory (MGB) and non-auditory structures (hippocampus). The expression of multiple GABA signaling components was assessed by qRT-PCR.

Results and Discussion: We found that hippocampal expression of the mRNA encoding the GABAA receptor gamma 2 subunit was significantly lower in rats with chronic tinnitus-like behavior than in control rats or noise exposed rats that did not develop tinnitus. Because this subunit is particularly important for postsynaptic clustering of major GABAA receptor subtypes, and it plays an important role in experience-dependent plasticity, we are further studying its spatial changes in the hippocampus. Analysis of GABA regulation in the medial geniculate body (MGB) is ongoing and will be presented.

GENETIC EVIDENCE FOR THE CONTRIBUTION OF GLUTAMATE IN OTOTOXIC-MEDIATED HEARING LOSS AND TINNITUS

Cederroth C.R., Hudspeth A.J.
The Rockefeller University and Howard Hughes Medical Institute, Department of Sensory Neuroscience, New York, 10065 NY, USA.

Background: Glutamate is thought to be the primary cause of noise- and medication-induced tinnitus. However, functional evidence for the role of glutamate in causing tinnitus is lacking. Here, we take advantage of the known resistance of mice to ototoxicity to test the hypothesis that glutamate causes drug-induced hearing loss and tinnitus in mice lacking GLAST. GLAST is a glutamate transporter present in support cells that pumps back the excess of glutamate released by inner hair cells during stimuli. Mice lacking GLAST display enhanced sensitivity to noise due to greater glutamate levels in the inner hair cell – afferent fiber synaptic cleft.

Material and Methods: We administered wild-type and GLAST KO mice with cisplatin or salicylate, measured their hearing functions by means of ABR and DPOAEs, evaluated the perception of tinnitus by the gap-detection method.

Results: Whereas wild-type mice showed no sensitivity to cisplatin and little deficit in the gap-perception (60% suppression of the startle-response versus 80% in vehicle treated mice), mice lacking GLAST showed elevated hearing thresholds up to 40 dB shifts with cisplatin, and 25% of suppression of the startle response, being highly suggestive of severe tinnitus percept.

Conclusions: Our results suggest that GLAST contributes to cisplatin-mediated hearing loss and tinnitus caused by salicylate. GLAST deficiency may serve as a model to study tinnitus in mice. Genetic differences in humans causing differential cochlear expression of GLAST may thus underlie people's degree of susceptibility in developing hearing loss or tinnitus. Finally, GLAST agonists may also prove useful to prevent from tinnitus induction by noise or medication.

CHANGES IN SOMATOSENSORY-AUDITORY INTEGRATION IN INFERIOR COLLICULUS ACCOMPANY NOISE INDUCED TINNITUS

Dehmel S, Parikh M, Bledsoe SC, Shore SE
University of Michigan, Dep. Otolaryngology, Ann Arbor, USA

Background: Ascending projections from a somatosensory structure, the spinal trigeminal nucleus (Sp5), and the cochlear nucleus converge in the guinea pig external nucleus of the inferior colliculus (ICx). Pairing electrical stimulation of the Sp5 with auditory stimulation suppresses, and sometimes enhances, neural activity in the ICx. Here we investigated the effects of noise-induced hearing loss on neural activity as well as somatosensory influence in the ICx and central nucleus of the IC (ICc).

Materials and Methods: Guinea pigs were unilaterally noise exposed. Gap detection testing monitored the development of tinnitus. After recovery of ABR thresholds, in vivo extracellular recordings were performed with 16 channel Neuronexus probes. Sp5 was electrically stimulated with bipolar concentric stimulation electrodes. Unit responses were examined before and during bimodal Sp5-sound stimulation. Recording and data analysis was performed by TDT software and hardware and SPSS.

Results: Noise exposure resulted in tinnitus in half of the animals, increased spontaneous rates in the ICx and reduced dynamic ranges of tone responses. Suppressive and enhancing bimodal integration occurred in ICx and ICc in normal control animals. After noise-exposure ICx showed primarily bimodal suppression, especially in animals with tinnitus while ICc showed primarily bimodal enhancement.

Conclusions: Previous findings show tinnitus accompanied by bimodal enhancement in DCN, suggesting bimodal stimulation elicits an opposite effect in ICx of tinnitus animals. Bimodal effects in ICC might reflect mostly transmission of already-processed information from DCN. ICx, on the other hand, appears to process bimodal information independently of DCN.

ROLE OF THE 5-HT SYSTEM IN TINNITUS: A SYSTEMATIC STUDY USING AN ANIMAL MODEL

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[2] *University of Buffalo, Center for Hearing and Deafness, Buffalo, USA*

Background: Serotonin (5-HT) has multiple functions in the brain, many of which are involved in emotion, attention and mood control. It is also present in the auditory system and has been implicated in tinnitus. Many scattered tinnitus trials with various drugs that target the 5-HT system have produced mixed results with the choice of drugs rather arbitrary. In our research we have started to systematically study the changes in 5-HT receptors and other components of the 5-HT system in various parts of the auditory system of animals with deafness-induced tinnitus.

Materials and Methods: Using a rat model of tinnitus (GPIAS) we have performed a detailed systematic screen of whether the 5-HT system is perturbed following induction of tinnitus. Tinnitus was induced unilaterally and bilateral brain regions were collected and analysed separately by quantitative PCR to determine changes in gene expression.

Results: We have analysed eleven brain regions with a panel of eleven genes and have described significant changes in gene expression of several key 5-HT related genes.

Conclusions: Using sensitive molecular biological techniques we have started to detail the changes in gene expression that occur in different parts of the auditory system following the induction of tinnitus. We have exciting preliminary data showing co-ordinated changes in gene expression in various parts of the brain in these animals. This works holds out the prospect of targeted use of already existing drugs to treat tinnitus and for the longer term, the hope of rational design of specific drug treatments.

THE ACUTE AND CHRONIC EFFECTS OF NOISE TRAUMA ON NEURONAL ACTIVITY IN THE INFERIOR COLLICULUS OF THE GUINEA PIG

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[2] *Graduate School of Medical Sciences, School of Behavioral and Cognitive Neurosciences, University of Groningen, Groningen, The Netherlands*

Background: Exposure to loud noise often results in (temporary) hearing loss and immediately occurring tinnitus. Additionally, noise trauma affects neuronal activity of the central auditory system. The aim of the current project is to study immediate changes in inferior colliculus (IC) activity after noise trauma and how these develop over several weeks.

Materials and Methods: Anesthetized guinea pigs were subjected to noise trauma (1hr, 11kHz, 124 dB). By measuring auditory brainstem responses (ABR), hearing thresholds were determined. Acute and chronic changes in neuronal activity of the IC were investigated by multichannel electrophysiology.

Results: Preliminary analyses of acute effects to noise trauma showed an ABR threshold shift to tones of 11 kHz and 22 kHz, whereas thresholds of 3 kHz, 6 kHz and click stimuli were unaffected. Likewise, tuning to tones completely disappeared in neurons with a characteristic frequency (CF) above 11 kHz. Spontaneous firing rate of IC neurons was increased ($p<0.001$). However, it appeared that a systematic increase of spontaneous activity was only present in neurons with a low CF.

Conclusion: Noise trauma resulted in an acute threshold shift at the high frequencies, measured with both ABR and electrophysiology. Against our expectations, noise trauma resulted in an immediate increase of spontaneous activity of IC neurons with a low tuning frequency and not of neurons tuned to high frequencies (at and above the trauma frequency). Further analysis will show to what extend these changes persist and develop over time.

04:00 - 05:30 p.m.

SESSION 4: Functional Imaging
Chair: Winfried Schlee

Room: Erasmus

DO AGING PROCESSES AFFECT TINNITUS PERCEPTION AND DISTRESS?

Winfried Schlee (1), Sven Vanneste (2), Dirk De Ridder (2) Berthold Langguth (3) & Iris-Tatjana Kolassa (1)

(1) Clinical and Biological Psychology, Ulm University, Germany
(2) TRI Tinnitus Clinic, BRAI²N, University Hospital Antwerp, Belgium
(3) Interdisciplinary Tinnitus Clinic, Department of Psychiatry and Psychotherapy, University of Regensburg, Germany

Humans are aging, and their brains are changing. The human brain possesses the potential to change its physiological properties throughout the lifetime. This neuroplastic potential is largely advantageous in such a way that it is the basis for lifelong learning and memory formation, for the adaptation to environmental, behavioral and metabolic changes as well as for the recovery from brain damage. While aging, all these changes accumulate over time leading to fundamental reorganizations of the brains structural architecture, it's functional organization and behavior. Is there an effect of theses aging processes on tinnitus? Is the nervous system in elderlies more vulnerable or more robust to develop tinnitus? Does the perception of the tinnitus sound change as the patients age? How does the patient's age affect the tinnitus-related psychological distress? Can we identify neurophysiological correlates for these aspects?

We started investigating these questions by a series of studies using data from self-assessment questionnaires, electroencephalic and magnetoencephalic recordings. In general, we find that patients with a tinnitus onset at older age are more vulnerable for high tinnitus-related psychological distress. Independent from the tinnitus duration, elderly patients describe their tinnitus more often as noise-like while younger patients report mostly a tone-like tinnitus perception. This is accompanied by consistent changes in the oscillatory activity from EEG and MEG resting-state recordings showing a general decrease for older subjects in the slow-wave (<4 Hz) and an increase in the beta/gamma frequency-range (>16 Hz), which is largely driven by functional changes from the medial temporal lobes.

ARE TINNITUS RELATED DISTRESS AND TINNITUS LOUDNESS DISTINCT TINNITUS FEATURES OR JUST TWO SIDES OF THE SAME MEDAL? RESULTS FROM EPIDEMIOLOGICAL, EEG- AND FMRI- STUDIES

W. Delb

Heidelberg University, Medical Faculty Mannheim, Dep. of Phoniatrics and Audiology, Mannheim, Germany

Background: Some tinnitus patients report a very loud and intrusive tinnitus but only a low tinnitus related distress suggesting that these parameters are distinct tinnitus features. Here we report data supporting this assumption.

Materials and Methods: The presentation includes data on 1. a questionnaire based survey in 4705 tinnitus patients, 2. a EEG study analysing resting EEGs of 46 male tinnitus patients and correlating the oscillatory brain activity of these patients with general audiological parameters and tinnitus related distress 3. a f-MRI study in 51 tinnitus patients who were stimulated with their own reconstructed tinnitus.

Results: In study 1 using data of a 256 item questionnaire obtained from 4705 tinnitus patients we were able to identify parameters that influence tinnitus related distress (e. g. depressivity, anxiety) and such parameters that influence tinnitus loudness (e. g. tinnitus awareness, hearing loss). In study 2 we were able to show a correlation of gamma brain activity originating in temporal brain areas and tinnitus loudness whereas tinnitus related distress was associated with theta activity. In study 3 we were able to identify activity in brain areas in the dorsolateral prefrontal cortex and the anterior cingulate cortex that show correlation ($r=0.69$, $p<0.0001$) with tinnitus related distress but not with audiological parameters.

Conclusions: These data suggest that tinnitus related distress and tinnitus loudness are distinct tinnitus characteristics, influenced by different clinical parameters, represented in different brain areas and associated with different kinds of oscillatory brain activity. Tinnitus loudness and tinnitus distress should therefore be addressed separately.

"DISTRESSED AGING": THE DIFFERENCES IN BRAIN ACTIVITY BETWEEN EARLY- AND LATE ONSET TINNITUS

Song J.J.[1], Vanneste S.[1,3], Van de Heyning P.[2], De Ridder D.[1]

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[3] Department of Translational Neuroscience, Faculty of Medicine, University of Antwerp, Belgium

Recent findings on different characteristics in tinnitus with regard to the age of onset prompted us to perform a study on the differences in the tinnitus-related neural correlates between late- and early-onset tinnitus (LOT and EOT) groups as well as between subjects with high distress (HD) and low distress (LD) in both groups. We collected quantitative electroencephalography findings of 29 LOT- and 30 EOT subjects as well as those of 59 controls. Then we performed inter-group analysis (LOT versus EOT), intra-group analyses (HD versus LD in both groups), and also between the 2 tinnitus groups and their age and sex-matched control groups using sLORETA-based source localization and connectivity analyses. Compared to the EOT- or old control groups, the LOT group demonstrated increased localized activities and functional connectivity in the components of previously described tinnitus distress networks as well as the default mode- and intrinsic alertness networks such as the prefrontal corticies (PFCs), dorsal anterior cingulate cortex (dACC), and insulae. In addition, while the HD-LOT subgroup showed increased activities primarily in the dACC than the LD-LOT subgroup, HD-EOT subgroup presented with increased activities primarily in the PFCs than in the LD-EOT subgroup. Increased dACC activity is characteristic in LOT patients, and more specifically HD-LOT patients while increased PFC activity is more salient in HD-EOT patients. The current findings of intrinsic differences in tinnitus-related neural activity between the LOT- and EOT groups may be applicable for both understanding pathophysiologic differences and for planning individualized treatment modalities.

ASYMMETRY IN PRIMARY AUDITORY CORTEX ACTIVITY IN TINNITUS PATIENTS AND CONTROLS

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[3] *Department of Nuclear Medicine and Molecular Imaging, University Medical Center Groningen, Groningen, the Netherlands*

Introduction: [18F]deoxyglucose (FDG)-PET scans in tinnitus patients showed larger metabolic activity in the left auditory cortex, as compared to the right auditory cortex in previously published literature. The asymmetry was irrespective of tinnitus lateralisation. This result suggested that tinnitus is associated with hyperactivity in the left auditory cortex.

Aim: The aim of this study was to compare the brain activity measured with FDG-PET scanning of chronic bilateral tinnitus patients to healthy control subjects.

Patients and Methods: FDG-PET scanning was performed in 20 chronic bilateral tinnitus patients and 19 control subjects, all right-handed. Subjects were scanned for 20 minutes, 30 minutes after injection of ~200 MBq FDG. Auditory input was prevented with earplugs and a headphone. PET images were analysed voxel wise and with Region of Interest (ROI) analysis based on Brodmann Areas (BA) using SPM5.

Results: With voxel wise analysis FDG-uptake was lower in tinnitus patients, compared with control subjects, in the anterior part of the left temporal lobe ($p < 0.001$, uncorrected). ROI analysis showed that the mean activity in the left (L) and right (R) primary, secondary and association auditory cortices was equally asymmetrical in both groups, L>R in BA41, and R>L in BA 42 and 22.

Conclusions: Asymmetrical brain activity in the auditory regions is similar in tinnitus patients and control subjects and is therefore unlikely to be the result of tinnitus. An area in the left temporal pole showed a significant difference between tinnitus and control subjects, suggesting it as potential target for localized treatment protocols.

INVESTIGATING THE TINNITUS BRAIN USING RESTING-STATE FMRI.

Maudoux A.[1-2], Vanneste S.[3], De Ridder D.[3], Vanhecke W.[3], Van de Heyning P.[4], Cabay J.-E.[5], Demertzi A.[1], Laureys S.[1-6], Soddu A.[1], Lefebvre Ph.[2], Gomez F.[1].

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Since it has been shown that correlation of low frequency fluctuations of resting BOLD activity reflect functional connectivity, an increased focus has been directed to functional MRI studies of the brain's baseline activity. Past studies in healthy volunteers showed that it is possible to identify consistent resting-state networks that have a functional relevance. Maps of these spontaneous network correlations have been proposed to provide tools for the understanding of clinical conditions. Taking functional and structural studies together on tinnitus, it is quite surprising that several studies have difficulties replicating results. Raising the question whether of this is related to the low sample size of these studies, the selection of non-representative patient subgroups or the absence of stratification according to clinical characteristics. Preliminary evidence by functional imaging studies using EEG and MEG indeed indicates that depending on the clinical characteristics, the neurophysiological mechanism differs in tinnitus patients. Therefore, we performed a resting-state fMRI study of a large cohort of tinnitus patients. Functional MRI Data were obtained for 130 tinnitus patients. Preprocessing was done using the SPM software and an ICA analysis was performed. 10 components of interest (default mode, auditory, salience…) were selected using an automatic selection method. We then performed analysis to indentify the effect of different tinnitus characteristic (TQ score, duration, intensity, type, lateralization…) on these different resting-state networks. We will discuss our results and relate these to previous findings using different neuroimaging techniques.

THE EFFECT OF TINNITUS ON RESTING STATE FUNCTIONAL CONNECTIVITY

Fatima Husain

Department of Speech and Hearing Science, University of Illinois at Urbana-Champaign, Champaign, Illinois, United States of America.

Background: The purpose of this study was to identify the effects of tinnitus and hearing loss on resting state functional connectivity. Resting state networks are characterized by fluctuations of spontaneous neural activity that occurs at rest, when no task is being performed. Because other disorders including schizophrenia and Alzheimer's disease have been shown to affect resting state networks, our hypothesis was that tinnitus would change the networks. In particular, we expected tinnitus to affect the auditory resting state network because of the presence of the phantom stimulus.

Materials and Methods: Functional MRI Data from 5 min continuous scan were obtained for three groups: normal hearing, bilateral hearing loss, and bilateral hearing loss with tinnitus. Data were analyzed using group-ICA method with GIFT software. Data from all subjects within the same group were combined for group analysis.

Results: There was more extensive response in the auditory resting state network in participants with tinnitus compared to other groups. The default mode network appeared smaller in the tinnitus group than in the normal hearing group, but the dorsal attention network was more pronounced in tinnitus subjects.

Conclusions: Our hypothesis, that tinnitus influences resting state networks, was supported by the results. Subjects with tinnitus did show differences in the auditory resting state network relative to the controls. Our results further suggest that that hearing loss alone may influence changes in the dorsal attention network, whereas tinnitus and hearing loss appear to alter the auditory and default mode networks.

05:30 - 07:30 p.m.
POSTER SESSION

Pathophysiology

P1. METHODOLOGICAL OPTIMIZATION OF TINNITUS ASSESSMENT USING PREPULSE INHIBITION OF THE ACOUSTIC STARTLE REFLEX

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Northeast Ohio Medical University, Department of Anatomy and Neurobiology, Rootstown, Ohio, USA.

Introduction: Recently prepulse inhibition of the acoustic startle reflex became a popular technique for tinnitus assessment in laboratory animals. This method confers a significant advantage over the previously used time-consuming behavioral approaches utilizing basic mechanisms of conditioning. Although this technique has been successfully used to assess tinnitus in different laboratory animals, many of the finer details of this methodology have not been described enough to be replicated, but are critical for tinnitus assessment.

Aim: The goal of this work is to help newcomers with the typically painful process of learning to correctly apply gap detection techniques for tinnitus assessment in laboratory animals. The major categories of discussion include: refinement of hardware, optimization of stimulus parameters, behavioral considerations, and optimal strategies for data analysis.

Results: Refinement of hardware Permeability of the animal restrainer to sounds and echo free testing stations are important for animal performance in the gap detection. Optimization of stimulus parameters The startle stimulus intensity and masking effects of the continues background on the startle stimuli during gap detection, if not addressed appropriately, may lead to inappropriate conclusions concerning tinnitus assessment. Behavioral considerations Animal acclimation and habituation are important to consider when a testing session is designed and conducted. Avoiding excessive stress typically improve animals' performance in gap detection during assessment of tinnitus. Data analysis Statistical Grubbs' test for identification of outliers in data sets, multiple presentation of the same stimulus, and conduction of multiple test sessions can significantly reduce undesired fluctuations in animals' behavioral responses to sound stimuli.

P2. THE BIOMARKER OF TINNTUS

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Background: Thus far, no objective measure has been developed to evaluate tinnitus severity. There is a close relationship between tinnitus and depression, in which brain-derived neurotrophic factor (BDNF) has a pathophysiological role. To determine whether BDNF levels could be used to evaluate tinnitus severity, we evaluated plasma BDNF levels in patients with tinnitus.

Materials and Methods: Plasma BDNF levels were measured in 43 tinnitus patients and 30 healthy control patients. The severities of tinnitus, depression, and anxiety were measured using the tinnitus handicap inventory (THI) and the hospital anxiety and depression scale (HADS), respectively. Patients with tinnitus were divided into 2 groups depending on their THI scores: mildly handicapped (<36) and severely handicapped (>38). We also divided our subjects into 2 groups depending on the HADS score, which represents patient mood, including depression and anxiety.

Results: Plasma BDNF levels were significantly higher in the mildly handicapped group than in the severely handicapped and control groups ($P<0.01$). Patients with HADS scores of ≤14 had significantly lower THI scores ($P<0.05$) and higher BDNF levels ($P<0.01$).

Conclusions: Our findings show for the first time that plasma BDNF levels vary with the severity of tinnitus, suggesting that plasma BDNF level is a useful tool for objective evaluation of tinnitus.

P3. TINNITUS TRIGGERED BY USE OF ORAL CIPROFLOXACIN: CASE REPORT

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Background: Tinnitus triggered by use of oral ciprofloxacin is rare and there are very few studies/reports in the literature which relate this symptom with this drug. The objective of this study is to report a case of tinnitus triggered by use of oral ciprofloxacin.

Materials and Methods: This paper is a case report of a patient who was followed on "PAZ" – Programa Anti Zumbido (Anti Tinnitus Program), a reference tinnitus clinic for the patients from the governmental social security program of Brazil.

Case Report: O.L.V., male, 62 years old, previously healthy, came to the PAZ´s clinic with bilateral tinnitus, sudden onset of constant awareness, non-pulsatile, such as a whistle, which occurs after 75 days of use of 1 gram/day of oral ciprofloxacin for treatment of chronic prostatitis, prescribed by the urologist for 90 days. In the first consultation, five days after the onset of the tinnitus, he reported 10/10 on a scale of degree of discomfort, associated to intense anxiety. It was suspended the use of oral ciprofloxacin and were prescribed 24mg of betahistine dihydrochloride, 12/12 hours plus 01 multivitamin capsule at lunch plus guidance for increase water intake and reduce coffee, chocolate, caffeine in general. Within the research comorbidities, merely audiometry revealed a bilateral sensorineural hearing loss from 3KHz. Sixty days after the episode, in the third consultation, he affirmed significant improvement of tinnitus awareness, with a degree of discomfort from 1/10, with excellent anxiety´s control.

Conclusions: Tinnitus is usually not recognized as a side effect in treatment with oral ciprofloxacin. Especially in elderly patients this complaint may be ignored or confused with any possible pre-existing condition.

Stop the use of oral ciprofloxacin for the first signs of tinnitus and introduce drug therapy immediately may be a therapeutic measure with relative efficiency to obtain relief of tinnitus awareness.

P4. BEHAVIOURAL EFFECTS OF TWO TINNITUS INDUCERS (NOISE EXPOSURE AND SALICYLATE) IN GUINEA PIGS

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Background: Behavioural models have proved essential in furthering our understanding of neural changes that accompany tinnitus. In rats, a model based on gap-induced pre-pulse inhibition (PPI) of the acoustic whole-body startle reflex is often used; however, this test is less reliable in guinea pigs due to rapid habituation of the reflex. We previously demonstrated that the pinna reflex could be used instead of the startle reflex. Here, we present data acquired using PPI of the pinna reflex following the application of two tinnitus inducers – noise exposure and sodium salicylate.

Materials and Methods: Following 3-6 baseline testing sessions, guinea pigs were subjected to either unilateral noise exposure or salicylate treatment (350 mg kg-1). Auditory brainstem response thresholds were recorded before and after noise exposure, and after a further 8 weeks of behavioural testing, to assess hearing status. Salicylate-treated animals were tested at 2h, 5h, and 72h post-injection.

Results: Significant behavioural changes were observed as a consequence of administering either tinnitus inducer. Depending on the strictness of the inclusion criteria, 25-80% of the noise-exposed animals were categorised as having tinnitus. All salicylate-treated animals displayed significant reductions in PPI of the pinna reflex.

Conclusions: The pinna reflex gap-detection test appears to be a suitable measure for identifying both short-term (salicylate) and chronic (noise-exposed) tinnitus. Application of strict inclusion criteria based on the hearing status reduces the possibility that the behavioural changes occur as a result of hearing loss; consequently the PPI deficits observed in many of these animals are likely due to tinnitus.

P5. NEURAL AND HISTOLOGICAL CORRELATES OF TINNITUS IN GUINEA PIGS

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Background: Animal models of tinnitus allow correlations between changes in neural activity in the auditory system, induced by acoustic trauma, and objective behavioural measures of tinnitus.

Materials and Methods: Guinea pigs (GPs) were subjected to unilateral noise trauma and tested for the presence of tinnitus over an 8-week period. Hearing status was assessed using auditory brainstem responses. The animals were then anaesthetised, and spontaneous firing rates (SRs) and frequency-response areas were measured for single-units in the inferior colliculus (IC). Subsequently, we examined changes in nitric oxide synthase (NOS) expression histologically in the cochlear nucleus.

Results: SRs were elevated in the IC of noise-exposed GPs, compared with controls, although no trend was apparent with regard to characteristic frequency. Using rigorous criteria for assessing the presence of tinnitus that eliminated GPs with any substantial asymmetric hearing loss, we found asymmetric NOS staining in the cochlear nucleus of three animals with tinnitus. In two animals with hearing loss but no tinnitus, we did not find asymmetric NOS staining.

Conclusions: These data support previous work showing elevated SRs in the IC following acoustic trauma. Moreover, our data show a marked, sustained change in NOS activity (an enzyme associated with pathological signalling) in the cochlear nucleus in GPs with tinnitus. Nitric oxide may play a role in post-acoustic trauma pathology in the cochlear nucleus: a structure that according to previous reports acts as a 'trigger zone' in driving tinnitus-related hyperactivity in higher auditory centres.

P6. BDNF AND GDNF GENES EXERT SEXUALLY DIMORPHIC EFFECTS ON TINNITUS SYMPTOMATOLOGY

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Background: Brain-derived neurotrophic factor (BDNF) and glial cell-line derived neurotrophic factor (GDNF) are essential to the early development of the central auditory pathway and inner ear. Both neurotrophins play key roles in the protection and repair of sensory epithelia, reduce ectopic discharges after nerve injury and induce neurite outgrowth in vitro. These properties suggest that genetic variants in the respective genes may help predict symptom intensity in chronic tinnitus, a condition frequently marked by central nervous hyperexcitability.

Materials and Methods: Five single nucleotide polymorphisms in the BDNF and GDNF genes (rs6265, rs2043046, rs3812047, rs884344, and rs1110149) were genotyped in 290 Caucasian patients who presented with tinnitus lasting more than six months. Tinnitus severity was graded using the Tinnitus Questionnaire (TQ).

Results: When a genotypic risk model was applied and age was corrected for, the five variants under study accounted for >18% of variance in women's TQ scores (p=0.05). However, multiple regression did not give a significant fit for TQ scores in men affected by tinnitus.

Conclusions: Distinct effects of BDNF and GDNF genes on tinnitus symptomatology in men and women add to neuroimaging findings on the gender-specific processing of stimuli by the human primary auditory cortex. More research is invited to determine the implications of this dimorphism for resilience and long-term recovery from tinnitus.

P7. ANALYSIS OF THE ASSOCIATION BETWEEN TINNITUS AND ARTERIAL HYPERTENSION: PRELIMINARY DATA

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Current trend of thought is to consider tinnitus a multifactorial symptom. Arterial hypertension has been suggested to be involved in some types of tinnitus'

pathophysiology. The prevalence of arterial hypertension in the general population has been reported to be between 24.8 and 33.7% in brazilian studies and between 11 and 54 % in european studies. Aim To analyze the association between tinnitus and arterial hypertension,in a prospective cross-sectional study. Patients and methods Currently, 46 tinnitus patients have been included and data was compared to previous epidemiological studies, including patients older than 18 years old in the general population. Results The prevalence of arterial hypertension was 43.5%, significantly higher than one of the other studies (p=0.004). Tinnitus with sudden onset was more frequent (68.4%) on patients with hypertension (p=0.025). THI and VAS scores didn't differ between the two groups. Conclusion These preliminary data suggest that arterial hypertension associated tinnitus tend to arise in a sudden way. The incidence of arterial hypertension in our tinnitus patients was significantly higher when compared to one of the studies of a general population. Further data may confirm these initial findings and allow to a more complex analysis, including audiological data.

P8. SPONTANEOUS FIRING RATES IN AUDITORY CORTEX IN RESPONSES FOLLOWING LONG-TERM EXPOSURE TO NON-TRAUMATIC AUDITORY STIMULI: A POTENTIAL TINNITUS CORRELATE?

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Changes of neural activity in animal models have been correlated with tinnitus. It has been described that anomalous tonotopic reorganization, increased spontaneous firing rates (SFR), increased neural synchrony and overrepresentation of specific frequencies in the brain in response to a nocive stimulus, are responsible for this phantom auditory perception.

The aim of this study is to determine if there is a decrease or an increase in SFR activity in the cat primary auditory cortex, after long term stimulation with different types of non-traumatic auditory stimuli; and to determine if there is a correlate between the SFR and the unit characteristic frequency (CF) with the stimuli used.

To determine the importance of the stimuli used and the potential to produce suppression and/or enhancement in the SFR, adult cats were divided in four different groups and exposed to moderate-level (~70 dB SPL), behaviorally-irrelevant sounds for several weeks to months; and compared against control cats. The sounds consisted of random tone pip ensembles or noise, with various bandwidths and center frequencies: 1) 2-4 kHz, 2) 4-20 kHz, 3) 4-8-16 kHz and 4) factory noise. We found that the SFR activity decreased within the exposure frequency range; and significantly increased outside the edges of the exposure stimulus; without presenting signs of hearing loss. Tonotopic map changes based on local field potentials (LFPs) showed overrepresentation of the edge frequencies. Steeper amplitude-level functions for LFPs suggested the presence of hyperacusis. These changes suggest mechanisms for the presence of tinnitus in the absence of hearing loss.

P9. HINTS FOR MOTOR CORTEX EXCITABILITY AS BIOMARKER FOR NEUROPLASTICITY IN TINNITUS

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Background: Tinnitus is a consequence of neuroplastic alterations along the auditory pathway. The main models of tinnitus are based on maladaptation in inhibitory mechanisms resulting in neural hyperactivity, i.e., reduced feed-forward inhibition and lateral inhibition. Transcranial magnetic stimulation (TMS) is capable to measure cortical facilitation and inhibition in motor cortex (motor cortex excitability). Applied in repeated sessions, repetitive TMS (rTMS) has also neuroplastic effects and has been shown to be a promising treatment strategy for chronic tinnitus by stimulating the auditory cortex. The aim of the present study is to investigate if motor cortex excitability might represent a general biomarker of altered neural processing in tinnitus which is not specific to the auditory system.

Materials and Methods: We analyzed several parameters of motor cortex excitability (motor threshold, intra-cortical inhibition, intra-cortical facilitation, and cortical silent period) in 200 patients with tinnitus and 100 healthy controls. Data used were collected in the context of clinical trials in patients with tinnitus or in the context of basic research in healthy controls.

Results: Preliminary analyses indicate a decreased intra-cortical inhibition indicating altered motor cortex excitability in tinnitus.

Conclusions: Our preliminary findings are in line to previous reports that changes in motor cortex excitability are associated with clinical improvement after rTMS in tinnitus. Thus, altered intra-cortical inhibition in tinnitus might not only display a correlate of response to rTMS treatment but also a general biomarker for altered neural excitability and plasticity in tinnitus.

P10. MANAGEMENT OF THE FLUCTUATING TINNITUS.

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Our experience with management tinnitus for 25 years has led us to the following steps in treating this particular kind of tinnitus with success. Presentation of the last 2 years of patients that presented with Fluctuating tinnitus from onset 265 and those that had developed fluctuations on top of their continuous tinnitus that they have had; 115 pts. Total number of patients presented 380. (a) All E.N.T. exams & tests, medications. Sleeping position of Worst affected ear. (b) Accompanied intermittent symptoms such – Snoring/ Rhino-sinusitis/ Headaches/ vertigo/ hyperacidity/itchy rashes. (c) Presence of Stressful unresolved conflicts; ongoing. Test thyroid function. Principal of Treatment: (1) Aggressive treatment of the rhino sinusitis. (Details follow). (2) All patients undergo comprehensive allergy tests; & desensitization. Also have to exclude some foods? Smoking. (3) Harmful Gravity Effects on the ear on the pillow may need correction of nasal septal deviations. We need bil. patent Eustachian tubes (4) Professionally resolve conflicts causing stress. + Or - sedatives – hypnotics. It takes 2- 4 months to have 80 – 95 % of the fluctuating tinnitus resolve. Patients with fluctuating tinnitus exhibit the cardinal behavior of allergic disease. i.e. intermittent presence with the exposure to the offenders. The

anatomical/physiological connections of the Immuno-Endocrine- CNS Axis will be shown. Also the gravity effect on the trigeminal vascular system/paranasal sinuses' drainage and the obstruction of the Eustachian tubes cannot be ignored.

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Auditory and Cognitive Sciences

P11. TEMPOROMANDIBULAR JOINT DISORDER, HEADACHE, AND NECK PAIN: HINTS FOR PUTATIVE TINNITUS SUBTYPES

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Background: There is evidence that not only the auditory but also the somatosensory system is involved in tinnitus. Certain sub-groups of patients can modulate their tinnitus with somatic maneuvers such as jaw, head or neck movements. There is also evidence that patients with tinnitus and temporomandibular joint disorders (TMJ) depicts a putative discrete tinnitus phenotype. The aim of this study is the analysis of the association of TMJ complaints, headache, and neck pain with tinnitus.

Materials and Methods: We analyzed 1200 patients enclosed in the Tinnitus Research Initiative database. We contrasted patients with and without TMJ complaints, with and without headache, and with and without neck pain with respect to demographic variables (age, gender), audiology characteristics (laterality, hearing level, etc.), questionnaires (tinnitus questionnaire, quality of life, etc.), and tinnitus rating scales (loudness, annoyance, etc.).

Results: Suffering from one of these complaints increases the probability to suffer from one of the other complaints. TMJ complaints were associated with younger age, female gender, masking by music or sounds, and modulation by somatic maneuvers. Patients with headache were younger, had higher scores in questionnaires and ratings, and showed more hyperacousis. Neck pain was associated with higher scores in questionnaires and hyperacousis.

Conclusions: Our preliminary analysis indicates that diverse somatic complaints in tinnitus are associated with specific characteristics. Relevant variables might be age, tinnitus and quality of life questionnaires, tinnitus specific numeric rating scales, masking by sounds, modulation by somatic maneuvers, and hyperacousis.

P12. PREVALENCE AND CHARACTERISTICS OF TINNITUS AFTER NOISE EXPOSURE DURING RECREATIONAL ACTIVITIES

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Introduction: Young people expose themselves to loud music during recreational activities and are at risk for acquiring tinnitus.

Aims: The aim of this study was to determine the prevalence and characteristics of tinnitus in youth exposed to noise during recreational activities.

Patients and methods: First, a questionnaire regarding recreational noise exposure and tinnitus was obtained. Second, in subjects with permanent tinnitus the hearing status was evaluated and a tinnitus analysis was performed.

Results: The questionnaire was filled in by 151 subjects between 18 and 30 years and showed that 80.13% of the respondents have experienced tinnitus after recreational noise exposure. Temporary and permanent tinnitus occurred in 91.74% and 8.26% respectively. Permanent tinnitus showed similar characteristics as temporary tinnitus regarding character, localisation and pitch. The probability of acquiring tinnitus is independent of the frequency and duration of attending music events. However, it was found that the probability of acquiring tinnitus was reduced in subjects wearing hearing protection.

Conclusion: The results of this study show that no predictors among the characteristics of tinnitus prognose whether tinnitus will be temporary or permanent after recreational noise exposure. The amount of time spent at music events was not related to the emergence of tinnitus. However, wearing hearing protectors can prevent tinnitus in youth. Therefore, it is important to educate youth about the risks of noise exposure during musical activities, as well as to inform them about preventive strategies such as wearing hearing protectors.

P14. EFFICACY OF EAR PLUG HAVE TO EVALUATE WITH REAL EAR PLUGGED RESPONSE

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Introduction: One of the important issues for the prevention of tinnitus is preventing NIHL (Noise Induced Hearing Loss). In this study we are evaluating the efficacy of ear plugs using the real ear measurement and make sure the under laying problem of the ear plugs or ear mold. Materials and Method: 2 hardness types of molded ear plug with 4 styles are evaluated using Real Ear Unplugged/Plugged Response(REUR/REPR) measure with Siemens Unity-2.

Results: In cases of the hard material, these show always a 2500Hz of high frequency notch of REPR in any style of ear plugs. however when occupying the boney meatal region, enough compression for under 1000Hz and eliminate the harmfull notch in any material. It will be occurred due to a cartilage conduction.

Conclusion: 1) Providing and addressing the adequate Ear Plugs are very important issue for the preventing the hearing loss and tinnitus for all workers. 2) When we choice the custam molded ear plugs or ear mold for workers or hearing aids wearers, we have to consider about softness of materials of mold. Hard material will be produced the harmfull gain in particular frequency rage. This study was technically supported by Ear Inc., USA.

P15. AN EVALUATION OF THE CONTENT AND QUALITY OF TINNITUS INFORMATION ON WEBSITES PREFERRED BY GENERAL PRACTITIONERS

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Background: The chronicity of tinnitus places a major burden on primary and secondary healthcare services. In our recent national survey GPs identified 10 online sources of information they currently use in clinical practice, but welcomed further concise and accurate information on tinnitus assessment and management.

Materials and Methods: The purpose of this study was to assess the content, reliability, and quality of the information related to tinnitus assessment and management on these 10 websites. Quality of information was rated using the validated DISCERN questionnaire. Significant inter-rater reliability was confirmed by Kendall's coefficient of concordance (Wt) which ranged from 0.48 to 0.92 across websites.

Results: The website 'Map of Medicine' achieved the highest overall DISCERN score. However, for information on treatment choice, the British Tinnitus Association was rated best. Content analysis revealed that all websites lacked a number of details relating to either tinnitus assessment or management options.

Conclusions: No single website provides comprehensive information, on tinnitus assessment and management and so GPs may need to refer to more than one if they want to maximise their coverage of the topic. From those preferred by GPs we recommend several specific websites as the current 'best' sources. Our findings should guide healthcare website providers to improve the quality and inclusiveness of the information they publish on tinnitus. Such developments will in turn help facilitate best practice in primary care.

P16. POSTTRAUMATIC TINNITUS: A TRI DATABASE EVALUATION

Kreuzer, P.

Background: Each year in the United States, approximately 1-2 million people experience a traumatic brain injury (=TBI) and it is found among the most common war related injuries due to blast and concussion with compensations actually totaling more than 1 billion dollars annually in US Army Forces.

Objective: In the present study we report prevalence of the history of traumatic brain injury as well as clinical and audiological characteristics among a worldwide sample of tinnitus patients. The data derive from the Tinnitus Research Initiative Database (TRI).

Materials: A total of 2187 patients from the Tinnitus Research Initiative (TRI) Database were investigated. Assessment was performed before the first consultation in the tinnitus clinics and included demographic data, the Tinnitus Sample Case History Questionnaire (TSCHQ), the Tinnitus Handicap Inventory, the Tinnitus Questionnaire, the Beck Depression Inventory, various numeric tinnitus rating scales, and four domains of the World Health Organisation Quality of Life Scale (WHOQoL). For analytical statistics we used a two-steps-approach with 1st conducting ANOVAS and chi-square-tests with the variable onset (no information / trauma / no trauma) and 2nd ANOVAS and chi-square-tests with the variable onset (no trauma / whiplash / noise trauma).

Results: Men experienced traumatic tinnitus causes more frequently than women. The groups differed significantly in the age at presentation and the age at onset. The duration of tinnitus was higher for the individuals with noise trauma and lower for individuals with head trauma and whiplash, no trauma subjects ranging in between.Patients with trauma history showed greater tinnitus impairment reflected by self-reporting questionnaire ratings in TQ and THI, and reported a higher prevalence of depressive symptoms according to the BDI. Although showing more subjective depressive symptoms patients suffering from trauma-associated tinnitus underwent current psychiatric treatment less frequently than patients without trauma history. Subjective numeric tinnitus rating assessment scales concerning the items loudness, discomfort, annoyance, ignorability, and unpleasantness and thus indicating the perceptional characteristics of tinnitus did not differ among the investigated groups.

Conclusions: Since tinnitus may be caused by a lesion or dysfunction at any level of the auditory system a multimodal approach combining different medical fields such as Otolaryngology, Neurology, Psychiatry, Psychotherapy, Audiology, Dentistry, Neurosurgery and patients' lay organizations is considered to be vital to improve both our current knowledge about the underlying pathophysiology of chronic tinnitus and to develop hypothesis-driven, innovative treatment options for the millions of patients concerned.

P17. COGNITIVE SPEED AS AN OBJECTIVE MEASURE OF TINNITUS

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Background: Subjective, chronic tinnitus is a common but poorly understood condition. The heterogeneity within tinnitus has hindered the development of severity measures and effective treatment. Tinnitus at least partially results from maladaptive cortical processes that are associated with cognitive deficits. This study examined whether cognitive processing speed might serve as a novel objective measure of tinnitus severity, and whether the psychiatric comorbidities of depression and somatization are predictive of self-reported tinnitus severity.

Materials and Methods: Cross-sectional study of 92 chronic tinnitus participants. The Tinnitus Handicap Inventory (THI) captured the self-reported severity of tinnitus. Cognitive processing speed was objectively measured by the Brain Speed Test (BST), a short computerized test from Posit Science®. Somatization and depression were captured by the Whiteley-7 and Patient Health Questionnaire-9 (PHQ-9) scales. The results of these tests were combined into a Composite Psychiatric State (CPS) variable. The ability of BST Z-score and CPS Level to predict THI was assessed.

Results: There was a significant correlation ($r=0.54$, $p<0.001$) between BST Z-scores and THI in those with severe tinnitus (THI≥30). Additionally, BST Z-score was correlated with the validated neuro-cognitive tests. Multivariate analysis identified BST Z-score and CPS Level as independent predictors of THI.

Conclusions: Cognitive processing speed, as defined by the BST, can serve as an objective measure of the severity of chronic, subjective tinnitus among those patients with severe tinnitus. Cognitive processing speed and psychiatric state are independent predictors of self-reported tinnitus severity. These measures increase understanding of the clinical subgroups within tinnitus.

P18. VALIDATION OF THE CHINESE MINI TINNITUS QUESTIONNAIRE

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Introduction: The Chinese Tinnitus Questionnaire (TQ-CH) has been shown to be a reliable and valid measure of general tinnitus-related distress. Despite its good psychometric properties, the application of TQ-CH in busy clinics has been hindered by the relatively long administration time required. It has been shown that the Mini-TQ (German version) has high reliability and validity, and is suitable for rapid assessment of subjective tinnitus distress.

Aim: The objective of this study is to validate the Chinese version of the Mini-TQ (Mini-TQ-CH) to be used in busy clinics.

Materials and Methods: TQ-CH was administered to 114 patients with chronic tinnitus in the Audiology clinic in a hospital setting. Statistical analysis was performed to determine and compare the psychometric properties of the abridged version and the full version of the questionnaire.

Results: The Mini-TQ-CH had good internal consistency reliability estimate (α = 0.86), which was comparable to that of the original version and the full TQ-CH. Significant correlations were observed between the Mini-TQ-CH and psychological distress, tinnitus-related problem ratings, and severity ratings.

Conclusion: The results suggest that the Mini-TQ-CH is a reliable and valid measure of general tinnitus-related distress that can be used in clinical settings to quantify the impact of tinnitus on daily living.

P19. A STUDY OF PROGNOSTIC FACTORS FOR TINNITUS RETRAINING THERAPY BY USING A MULTIVARIATE ANALYSIS

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Background and Aim: Tinnitus retraining therapy (TRT) is one of the well-known treatments for facilitating habituation to tinnitus. However, the effects of TRT vary in different patients. This study aimed to identify factors affecting TRT efficacy by using the multiple logistic regression analysis.

Patients and Methods: One hundred seventeen tinnitus patients who had received TRT for at least 12 months were included. As well as the audiologic evaluation, the following questionnaires were examined before the treatment; the Tinnitus Handicap Inventory (THI), the Self-rating Depression Scale (SDS), the State-Trait Anxiety Inventory (STAI) and the Japanese version of the Emotional Intelligence Scale (EQS). The EQS is a tool for evaluating emotional intelligence and consists of 3 subscales; intrapersonal, interpersonal, and situational. After TRT for 12 months, the treatment effects were evaluated, and the patients were divided into 2 groups: TRT-effective and TRT-ineffective.

Results: TRT was judged effective in 80 patients (68.4%). Intergroup differences in age distribution, THI scores, duration from tinnitus onset, and audiologic findings, such as hearing levels and tinnitus loudness, were not significant. However, the SDS and STAI scores were significantly lower and scores of 3 EQS subscales were significantly higher in the TRT-effective patients than in the TRT-ineffective patients. The multiple logistic regression analysis revealed that the situational EQS score was the only significant factor affecting the effectiveness of TRT.

Conclusion: Emotional ability to adapt to the situation surrounding oneself and its change is considered the most important predictor of TRT effectiveness.

P20. TINNITUS: DISTINGUISHING BETWEEN SUBJECTIVELY PERCEIVED LOUDNESS AND TINNITUS-RELATED DISTRESS

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Background: There exist a variety of tinnitus therapies but their overall success is low. One reason for this may be the heterogeneity of tinnitus patients. Subclassification is expected to improve therapeutic allocation of tinnitus patients which in turn is hoped to improve therapeutic success for the individual patient. Tinnitus complaints can be classified into categories reflecting the perception of the tinnitus sound and into categories reflecting reactions to this perception. Tinnitus perception is represented by the subjectively perceived loudness whereas reactions are comprised under tinnitus-related distress.

Materials and Methods: In a questionnaire-based cross-sectional survey we analyzed the data of 4705 individuals. The screening questionnaire contained measures for subjective tinnitus loudness, hearing impairment, and sleep quality, as well as psychometrically validated questionnaires addressing tinnitus-related distress, depressivity, anxiety, and somatic symptom severity.

Results: The present data contribute to the distinction between the subjectively perceived loudness of the tinnitus, and the tinnitus-related distress as partly separate characteristics of the tinnitus. Whereas the subjectively perceived loudness was specifically associated with the degree of awareness and binaural localization of the tinnitus, tinnitus-related distress was especially associated with anxiety, depressivity, and somatic symptom severity.

Conclusions: The subjectively perceived tinnitus loudness and the potential presence of severe depressivity, anxiety and somatic symptom severity should be assessed separately from tinnitus-related distress. If loud tinnitus is the major complaint together with mild or moderate tinnitus-related distress, therapies should focus on auditory perception. If levels of depressivity, anxiety or somatic symptom severity are severe, therapies and further diagnosis should focus on these symptoms at first.

P21. GENETICS ON FAMILY MEMBERS WITH TINNITUS

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Background: Tinnitus, the phantom perception of sound in the absence of overt acoustic stimulation, is a prevalent disorder. One in ten adults has clinically significant subjective tinnitus, and for one in 100, tinnitus severely affects their quality of life. Tinnitus is predicted to occur due to a broad variety of etiologies and pathogeneses. In a current common view, tinnitus is primarily linked to damage in the periphery of the auditory system, probably even in cases in which an impairment cannot be assessed by

clinical routine audiometry. From animal studies, it is hypothesized that an increased spontaneous discharge rate in subcortical auditory neurons and increased neural synchrony and hyperactivity in the auditory cortex are correlates of tinnitus. The subcortical hyperactivity is currently interpreted as a consequence of the loss of the stimulus-driven activity that triggers centrally compensating synaptic adjustments.

Aim: If hyperactivity is the general consequence of the cochlear damage that leads to tinnitus, why is it that not any cochlear damage and any type of hearing loss lead to tinnitus? Only a fraction of subjects suffering from hearing loss are affected by tinnitus. There is also no doubt that tinnitus is linked to stress. Is it possible that there is a hereditary predisposition of tinnitus?

Methods: We questioned a hereditary origin of tinnitus analysing family members in which monozygous twins developed tinnitus at the approximately same age in mid life. Information on both affected twins as well of family members was compiled from medical records, including successive audiological assessments. DNA was extracted from peripheral blood lymphocytes and mutagenesis performed by standard procedures. PCR primers were designed to amplify for polymorphism or exons and their flanking regions of genes of interest.

Results: We will present the first result of genotyping and first screening approach of several family members. The outcome will be discussed in the context of the audiometric and psychoacoustic analysis as well as questionnaire of the family members.

P22. THE PREVALENCE OF TINNITUS IN CHILDREN IN POLAND

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Background: Tinnitus in children is still rarely mentioned in medical literature. The prevalence of pediatric tinnitus has been reported to range between 13-37,5% in normally hearing children and 7,0-58,6% in children with hearing loss.

Aim: The objective of this study was to estimate the prevalence of the tinnitus in 7 and 12 years old children in Poland.

Material and methods: In this study 118005, parents of 7-year old children and 25691, 12-year old children and their parents were asked about the presence of tinnitus using a questionnaire. Additionally, before a hearing screening test at school 7-year old children were asked by a tester if they can hear noise in their ears or head. The hearing screening test was performed using screening audiometer with air conduction.

Results: The results showed that according to parents questionnaire answers tinnitus was present in group of 15244 (12,9%) 7-year old children and in group of 4082 (16,8%) 12-year old children. Among the 7-year old directly asked about tinnitus 29,3% (34517) mentioned to have it. Group of 8980 (35,0%) 12-year old confirmed in the questionnaire to have tinnitus. Differences in the presence of tinnitus between 7 and 12-year old children have proven to be statistically significant. Children with hearing loss reported tinnitus more frequent comparing to children with normal hearing.

Conclusions: Tinnitus is a frequent condition among 7 and 12 y. o. children. Hearing loss and age seem to be risk factors of children tinnitus (OR>1)

P23. TINNITUS IN SCHOOL AGE

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Introduction: Tinnitus is a hearing sensation without any external stimulation. It is not uncommon in the pediatric population, nevertheless it remains a neglected problem particularly in normal hearing children. A tinnitus prevalence ranging from 13% to 29% in normal hearing children and a prevalence of 59% of the children with hearing loss was observed1. Tinnitus may cause several disorders in children and affects their quality of life: difficulties in concentration, irritation and sleeping trouble1.

Objective: To determine the prevalence, consequences regarding the attention span and the potential pathologies related to tinnitus in school age.

Material and Methods: Prospective and descriptive study with analytical component and quantitative approach. Thirty four children aged from 6 to 12 years were evaluated. It were performed anamnesis with specific questionnaire, otorhinolaryngological appointment, pure tone audiometry, speech audiometry, tympanometry and stapedial reflex.

Results: The tinnitus was reported by 15 of the 34 studied children. With regard to the involved ear, the left one was the most affected (n=7), followed by both ears (n=5) and right ear (n=3). With respect to the quality of the tinnitus, the insect-like noise was the most reported (n=7). A significant number of children (n=7) who claimed to have tinnitus had a past of otitis. The only finding in the exams was a Eustachian tube dysfunction in one patient.

Conclusions: The tinnitus is a common symptom in the pediatric population and the otitis is considerably associated with its etiology.

1 A Shetye, V Kennedy. Tinnitus in children: an uncommon symptom? Arch Dis Child 2010;95:645–648

P24. RESIDUAL HEARING AREA QUANTIFICATION (RHAQ) IN COCHLEAR IMPLANT USERS SUFFERING FROM PARTIAL DEAFNESS.

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Background: Hearing preservation (HP) has become a high priority in cochlear implant (CI) surgery, especially in electric acoustic stimulation (EAS). Therefore a conventional and user-friendly method is required to describe and to quantify this low frequency residual hearing (RH) in partial deafness (PD). The aim of the study was to develop a practicable method to quantify RH in all hearing-impaired patients. This study reports the quantification of the mean RH of an EAS patient group.

Methods and Patients: The authors developed a Residual Hearing Area Quantification (RHAQ). This method quantifies RH using a percentage based on the proportional area under the curve of the entire conventional tonal laminar audiogram from 0,125 till 8kHz. A retrospective audiogram review was performed in 27 EAS users suffering from PD who were implanted with a HP surgical technique

using the Medel multichannel device with M, FLEXEAS or FLEXSOFT electrode. Preoperative and postoperative RH was calculated using RHAQ.

Results: Their mean pre-implantation RH is 33.23% (σ=0.08). After EAS surgery they still retained 24.25% RH (σ=0.09). This is 72.98% of their pre-implantation RH.

Conclusion: The EAS study group started pre-implantation with 33.23% RH. After they underwent HP surgery and received an EAS system, they still have 24.98% RH. Based on these HP percentages, using RHAQ, we can conclude that the EAS study group preserved 72.98% of their hearing.

Treatment

P25. NEUROSCIENCE AND PSYCHOANALISYS ON TINNITUS RESEARCH

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Introduction: As a human phenomenon tinnitus has a psychological and a physiological components, so the best two ways for studying it is through psychoanalysis and neuroscience.

Aim: To demonstrate it is always possible to find out the tinnitus origin in every patient with the correct interrogatory; and to prove the true tinnitus mechanism through the effective treatment based on neuroscience.

Materials and method: Twenty tinnitus patients were taken from external consultation of the Fundacyt who were assessed with psychoanalysis and Objective Accouphenometry (OA) and treated with amitriptiline in special doses and schedule.

Results: In all twenty patients we could find out the event that originated tinnitus. The OA was confirmed in 16 from 20 patients. Ten patients reported reduction in tinnitus intensity after the first “cure”; six patients reported reduction after the second “cure”; three patients reported the reduction after the third “cure”, one patient did not tolerate the amitriptiline, she had to be excluded.

Conclusions: 1. When tinnitus patient is assessed with the appropriate interrogatory it is always possible to find out tinnitus´s origin. 2. When tinnitus treatment is based on the true neurophysiologic mechanism treatment is effective. 3. This true mechanism includes the two main kind of brain neurotransmitter: excitatory glutamate, aspartate and inhibitory GABA and glycine.

P26. REDUCTION OF TINNITUS SEVERITY BY THE CENTRALLY ACTING MUSCLE RELAXANT CYCLOBENZAPRINE: AN OPEN-LABEL PILOT STUDY

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We report five open-label exploratory pilot studies to assess the effectiveness of muscle relaxants acting on the central nervous system on tinnitus patients.

Cyclobenzaprine at high (30 mg) and low doses (10 mg), orphenadrine (100 mg), tizanidine (24 mg) and eperisone (50 mg) were administered to a maximum of 20 patients per group over a 12-week period. High-dose cyclobenzaprine resulted in a significant reduction in the Tinnitus Handicap Inventory (THI) score between baseline and week 12 in the intention-to-treat analysis. All other treatments were not effective. These results were confirmed in an explorative analysis where baseline corrected Tinnitus Handicap Inventory and Clinical Global Impression scores at week 12 were compared between groups. This study results on a new promising pharmacological treatment for tinnitus. Further randomized, placebo-controlled, double-blind studies of the use of cyclobenzaprine on tinnitus patients should follow this open-label exploratory trial.

P27. INTERNET-BASED SOUND THERAPY (IBST) FOR TINNITUS

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There is a growing concensus that the treatment of tinnitus should include sound therapy (ST). Hearing aids and noise generators (maskers) have been widely recommended for tinnitus patients for decades. Their effectiveness and user acceptability, however, has been questioned. Since intensive counceling was introduced as a crucial part of tinnitus therapy, TRT program (using ST through white noise and environmental enrichment) and modifications of TRT with varying types of ST have yielded improved therapeutic effects. These treatment strategies aim to reduce the aversive reaction triggered by chronic tinnitus and to habituate an individual to live with his tinnitus, not to reduce the tinnitus sensation itself.

Recently, it has been shown that both the tinnitus triggered distress and the sensation of tinnitus can be positively affected by stimulating the auditory system by sound, particularly by using various individually tailored ST paradigms such as notched music.

In general, standardized ST-solutions seem not be therapeutically optimal. In contrast, they should be individually tailored, interactive and easily adjustable. The leading principle should be individual authority (often contrasting product efficacy). This means that the goal of ST should in each case be defined in detail. In acute tinnitus, masking-type of ST may be useful to prevent worsening of tinnitus annoyance and subsequent distress. In chronic tinnitus the primary target might often be the tinnitus-triggered distress. The next step might be the specific ST for tinnitus mitigation or habituation.

Our IBST solution enables easy access for any professional to receive appropriate tools to define a tinnitus and hearing profile of each patient and subsequently form acoustic therapy material from a broad range of carefully chosen sound sources (music, nature sounds), individually tailored for each patient.

P28. EFFECT OF DIFFERENT SOUNDS ON THE TREATMENT OUTCOME OF TINNITUS RETRAINING THERAPY

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Objectives: Tinnitus retraining therapy (TRT) is composed of directive counseling and sound therapy. It is not well known if different types of sounds may result in different outcomes. In this study, we have tried to elucidate the effect of sound therapy when using different types of sounds: narrow band noise (nTRT), mixed noise (mTRT), and broad band noise (bTRT).

Material and methods: Forty one patients who have been followed up for more than 2 months were classified into three groups: nTRT (n=8), mTRT (n=13), and bTRT (n=20). PTA, tinnitogram, LDL, THI, VAS on annoyance, hours of tinnitus awareness were evaluated before treatment and every month after treatment. For the nTRT group, narrow band noise matched to the patient's perceived tinnitus was introduced. For the bTRT group, white noise was introduced. For the mTRT group, sequentially arranged narrow band and broad band noise was introduced.

Results: THI and VAS score improved significantly in all three groups after 5-12 weeks of TRT (nTRT, p=0.047 and 0.012; mTRT, p=0.020 and 0.010; bTRT, p=0.018 and 0.001). THI score improved most in the bTRT group and least in the nTRT group. The proportion of patients who improved >10 THI scores was significantly larger in the bTRT group (65.0%) when compared to that of the nTRT group (37.5%, p=0.049).

Conclusion: All three types of noises were able to provide relief. However, there was a significant difference in the therapeutic outcome according to the type of noise introduced. Broad band noise seems to have a better effect than the narrow band noise.

P29. TRANSCRANIAL DIRECT CURRENT STIMULATION (TDCS) INTENSITY AND DURATION EFFECTS ON TINNITUS SUPPRESSION

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Background: Non-invasive brain stimulation using tDCS has been proposed as a potential treatment intervention for tinnitus. Anodal tDCS of the Left Temporoparietal Area (LTA) and Dorso Lateral Pre Frontal Cortex (DLPFC) is potentially the most favourable polarity and sites of stimulation for tinnitus relief.

Materials and Methods: This pilot study aimed to determine anodal tDCS (LTA) dose (current intensity and duration) response effects for tinnitus suppression. Twenty-five participants with chronic tinnitus and a mean age of 54 years took part. Participants were screened for contraindications to tDCS by a neurologist. Anodal tDCS of LTA was carried out. Current intensity (1 mA and 2 mA) and duration (10 min, 15 min and 20 min) were varied and their impact on tinnitus was measured.

Results: tDCS was well tolerated by all participants. Fifty six percent of participants (14) experienced transient suppression of tinnitus, 44% of participants (11) experienced longer term improvement of tinnitus symptoms (overnight - less annoyance, more relaxed and better sleep). There was an interaction between duration and intensity of the stimulus on the change in rated loudness of tinnitus ($F(2, 48) = 4.355$, $p = 0.018$) and CGI score ($F(2, 48) = 3.193$, $p = 0.050$) after stimulation.

Conclusions: Two mA current intensity and 20 minute duration were the most effective stimulus parameters. tDCS may be a potential clinical tool for patients with tinnitus although more research is needed in this area.

P30. MULTISITE RTMS FOR THE TREATMENT OF CHRONIC TINNITUS: STIMULATION OF THE CORTICAL TINNITUS NETWORK – A PILOT STUDY

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Background: Low-frequency repetitive transcranial magnetic stimulation (rTMS) of the auditory cortex has been shown to significantly reduce tinnitus severity in some patients. There is growing evidence that a neural network of both auditory and non-auditory cortical areas is involved in the pathophysiology of chronic subjective tinnitus. Targeting several core regions of this network by rTMS might constitute a promising strategy to enhance treatment effects.

Objective: This study intends to test the effects of a multisite rTMS protocol on tinnitus severity.

Methods: 45 patients with chronic tinnitus were treated with multisite stimulation (left dorsolateral prefrontal, 2000 stimuli, 20 Hz; left temporoparietal, 1000 stimuli, 1 Hz; right temporoparietal, 1000 stimuli, 1 Hz) on ten consecutive working days. Results were compared with data from 29 patients who were treated with left temporal stimulation (2000 stimuli, 1 Hz). Tinnitus severity was assessed at three time points: at baseline, after the last treatment session (day 12) and after a follow-up period of 90 days. A change of tinnitus severity over time was tested using repeated measures ANOVA with the between-subjects factor treatment group.

Results: Both groups improved similarly from baseline to day 12. However, there was a difference on day 90: the multisite stimulation group showed an overall improvement whereas patients receiving temporal stimulation returned to their baseline level of tinnitus severity.

Conclusions: These pilot data suggest that multisite rTMS is superior to temporal rTMS and represents a promising strategy for enhancing treatment effects of rTMS in tinnitus. Future studies should explore this new protocol with respect to clinical and neurobiological effects in more detail.

P31. COMPARISON OF THE THERAPEUTIC EFFICACY OF ONE-ON-ONE VS. SMALL-GROUP COUNSELING BASED ON MODIFIED TINNITUS RETRAINING THERAPY

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Objectives: Tinnitus retraining therapy (TRT) is known as the effective treatment for patients with tinnitus and directive counseling is the most important component of TRT. Considering the difficulty giving one-on-one counseling in clinical practice due to time limitations, we hypothesized that small-group counseling may be as effective as one-on-one counseling and performed this study to evaluate the therapeutic efficacy of our modified TRT in different-sized small groups.

Methods: This study included 266 patients who presented with sensorineural tinnitus and were treated with modified TRT between January 2009 and December 2010. The patients received one-on-one (n = 95), one-on-two (n = 24), one-on-three (n = 47), or one-on-four (n = 100) directive

counseling by one ear, nose, and throat specialist. Therapeutic efficacy was evaluated using a tinnitus questionnaire.

Results: The initial score of the tinnitus handicap inventory (THI) and visual analog scales of loudness, awareness, annoyance, and effect on life of tinnitus did not differ statistically among the groups (P > .05). In all groups, the tinnitus questionnaire scores from the baseline to the 3- and 6-month follow-ups showed significant serial improvement with no intergroup differences. The THI score also improved significantly after treatment in all groups. Compliance with the treatment did not different among the groups.

Conclusions: Small-group counseling as a modified method of directive counseling for TRT was as effective as one-on-one counseling in our clinical setting. We feel that small-group counseling can be used in busy tinnitus clinics with the expectation of similar therapeutic efficacy of TRT in patients with tinnitus

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P32. MULTICENTRIC STUDY IN SLIGHT HIPOACUSIAS, DISABLING TINNITUS AND INTEGRAL THERAPY OF THE TINNITUS

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Introduction: Tinnitus is accompanied by hipoacusia in a 86% of the cases, reason why the study of both symptoms must be made in joint and comparative form. The introduction of new audioprotesic techniques allows making auditory corrections in a selective frecuencial way as well as to offer correct hearing. By incipient that pronounces the auditory loss, it is necessary to facilitate acoustic stimulus suitable to the auditory pathway like treatment of the bioelectrical dysfunctions that can origin chronic tinnitus, causing in addition diverse auditory and emotional distortions types. The negative meaning of Tinnitus favors its detection, granting greater relevance by itself, by such reason will be necessary apply specific techniques. The measurement of the Tinnitus develops new tests including the influence in the daily life of the patient and the valuation of the incapacity levels that it generates to him.

Methodology: It is used a protocol of valuation and follow up between 6 months and a year after to have begun the therapy. Valuing a sample of 100 patients, fitted in several GAES IAI centers (Burgos – Bilbao – Madrid – Zaragoza – Las Palmas – Tenerife – Alicante – Santander – Barcelona). In all the cases, auditory correction, sonorous Therapy through the stimulation of accustoms sounds and audioprotesic advice on tinnitus was used.

Material: TEST THI – Tinnitus Questionnaire - Sheldrike - VAS.

Results: In the sample of 100 patients treated by means of the Integral Therapy of the Tinnitus, different improvement values were obtained, that can be demonstrated through standardized test.

Conclusions: The perception of the Tinnitus diminishes after normal stimulation of hearing and sound enrichment. The improvement of the incapacity caused by Tinnitus is significant better in the slight hearing losses, when it is stimulated with accustoms sounds and that contributes to significant decrease on the Tinnitus resistance in quite acoustical environments.

P33. EFFECTIVENESS OF BILATERAL REPETITIVE TRANSCRANIAL MAGNETIC STIMULATION IN PATIENTS WITH CHRONIC TINNITUS

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Background: Repetitive transcranial magnetic stimulation (rTMS) has been applied in several studies as a possible treatment of chronic tinnitus. The few randomized controlled trials among these studies suggested a limited effect. Here we present a double blind randomized controlled trial in which 50 patients with chronic tinnitus were treated with rTMS on both the left and right auditory cortex.

Materials and Methods: Fifty patients (41 male) with chronic tinnitus (duration > 2 months) were treated between June 2007 and June 2011 with either rTMS using a figure-8 magnetic coil or sham stimulation using a placebo coil. Treatment existed of 2000 stimuli of 1Hz rTMS on 110% of the motor threshold during five consecutive days. Both auditory cortices were treated; the location was determined through neuronavigation. The primary outcome parameter was the change in tinnitus burden measured by the tinnitus questionnaire. Secondary outcome parameters were a visual analogue scale and the tinnitus handicap inventory. These measures were acquired up to six months after treatment.

Results: The average effect of rTMS, immediately after treatment and on the long term, was small and clinically not relevant.

Conclusions: In agreement with previous randomized controlled trials, the effect of bilateral low-frequency rTMS of the auditory cortex in our tinnitus patients was poor at best.

P34. PROGNOSTIC MODELS FOR CHANGES IN TINNITUS HANDICAP AFTER COCHLEAR IMPLANTATION

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Background: Tinnitus is a common phenomenon in cochlear implant candidates. In most cases, tinnitus is unchanged or reduced after implantation. Unfortunately, tinnitus is aggravated in a small portion of implant recipients. It is still unclear which pre-operative factors can predict change in tinnitus after cochlear implantation. In this study we created prognostic models for changes in tinnitus handicap after cochlear implantation

Material and methods: We studied these models by means of 2 retrospectively send questionnaire booklets; one assessed the situation before implantation and the other the situation after implantation. We mostly used standardized questionnaires that contained questions concerning tinnitus handicap (THI, THQ), tinnitus

characteristics, hearing loss (APHAB), personality (DS-14, LOT), anxiety/depression (HADS) and life events. In total, 117 patients (aged 61.4 ± 14.4; 68 female, 49 male) were included (response rate of 55%).

Results: The models were tested by multiple regression analyses. We included the following preoperative factors as independent predictors: preoperative scores on THI/THQ, DS-14 negative affect, HADS depression and APHAB. The difference in preoperative and postoperative scores on the THI/THQ were used as dependent outcomes. In this way we could predict 47% of the THI ($p<0.01$) and 44% of the THQ variance ($p<0.01$). The most important predictor seems to be the preoperative score on the handicap questionnaires.

Conclusions: Preoperative questionnaires have moderate predictability for the difference in preoperative and postoperative tinnitus handicap scores.

P35. ACOUSTIC CR NEUROMODULATION COUNTERACTS IMBALANCE OF CAUSAL INTERACTIONS OF BRAIN AREAS IN PATIENTS WITH SUBJECTIVE CHRONIC TONAL TINNITUS

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Background: Subjective tinnitus is an auditory phantom sensation, which evolves as a consequence of damage to the peripheral auditory system and causes characteristic changes of brain activity. A mechanism, underlying the perception of a phantom sound, is likely to include the imbalance in communication between auditory and non-auditory brain areas. Recently, it was shown that acoustic CR neuromodulation significantly counteracts both tinnitus symptoms and tinnitus related alterations in EEG power spectra1. Here we study the impact of CR neuromodulation on effective connectivity between auditory and non-auditory brain areas.

Methods: EEG recordings were performed at baseline and after 12 weeks of CR therapy in 28 patients with bilateral chronic tinnitus and in a control group of healthy subjects. We performed a BESA source reconstruction in the following predefined regions of interest: temporal and frontal areas, parietal cortex, and anterior and posterior cingulate cortex. To reveal changes in connectivity, we used a combined empirical mode decomposition and partial directed coherence data-driven approach2. Dynamic causal modeling was used to infer the types of interactions, which were altered by CR neuromodulation.

Results: Acoustic CR therapy induces statistically significant changes of the effective connectivity in the delta, alpha and gamma frequency bands. In particular, we observed a significant reduction of the excitatory driving from the cingulate area to the primary auditory cortex together with an increased inhibitory interaction between the dorsolateral-prefrontal cortex and primary auditory cortex. Moreover, CR neuromodulation eliminates statistical differences in effective connectivity between the control group and a subgroup of good responders (with a TQ reduction after 12 weeks of ≥ 12).

1 Tass P.A., et al. Rest. Neurol. Neurosci. 30 (2012)
2 Silchenko A.N., et al. J. Neurosci. Meth., 191, 32-44, (2010)

P36. SUPPRESSION OF TINNITUS IN A PATIENT WITH UNILATERAL SUDDEN HEARING LOSS: CASE-REPORT

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Background: One model of tinnitus neurophysiology is the theory of an auditory phantom perception related to maladaptive attempts at cortical reorganization due to peripheral deafferentation. The aim of this work is to demonstrate the efficacy of ReSound Live TS combination to suppress tinnitus in a patient with unilateral sudden hearing loss.

Materials and Methods: A 67-year-old Caucasian woman came to our attention with complaints of severe disabling right-sided tinnitus, hyperacusis and headache. The tinnitus was associated to sudden right-sided hearing loss and vertigo, which occurred about 18 months before. In spite of different therapies there was no hearing improvement. Meanwhile the tinnitus worsened in the right ear with a narrow band noise at 6 kHz. Insomnia and concentration problems due to tinnitus lead to severe disability and a poor quality of life (THI: 80). Pure tone audiometry testing revealed right-sided ski-slope hearing loss on high frequencies and mild hearing impairment on the high frequencies in the contralateral side. DPOAE were present in the left ear and absent in the right ear. Magnetic resonance imaging (MRI) resulted in normal anatomical structures of the cochlea and the cranial nerves showing a partial empty sella syndrome with suprasellar cistern hernia. Angio-MR revealed a contact between the anterior inferior cerebellar artery (AICA) and the acoustic-facial nerve with a potential neurovascular conflict. Surgery was considered unnecessary after further evaluations.

Results: The right ear was successfully treated with a ReSound Live TS combination. Shortly after a standard fitting procedure the patient reported a reduction of her tinnitus and hyperacusis. The tinnitus completely disappeared at the follow-up evaluation after 3 months (THI: 20).

Conclusion: This case report demonstrates that ReSound Live TS combination resulted in a complete tinnitus suppression in a patient with unilateral sudden hearing loss. Our report further supports the restoration of peripheral sensory input for the treatment of tinnitus associated to hearing loss. The effectiveness can be explained with the plastic reorganization of the central auditory nervous system due to this treatment, which has to be carefully assessed and individualized in selected patients.

P37. COMPUTATIONAL ANALYSIS OF LONG-LASTING DESYNCHRONIZATION BY ELECTRICAL AND SENSORY COORDINATED RESET NEUROMODULATION

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Introduction: Pathological neuronal synchronization is a hallmark of several neurological disorders like Parkinson's disease or tinnitus. We investigate coordinated reset (CR) neuromodulation designed to counteract the abnormal neuronal synchronization and compare direct electrical and indirect, synaptically-mediated CR stimulation. The former stimulation mimics local effects of electrical deep brain CR stimulation, whereas the latter stimulation modality

represents a framework of sensory, e.g., acoustic CR neuromodulation for the treatment of tinnitus.

Methods: We consider two models of oscillatory neuronal populations of spiking and bursting neurons with excitatory and inhibitory interactions and with regular and random coupling topology equipped with spike timing-dependent plasticity. Direct electrical and synaptically-mediated CR stimulation was administered to such networks in strongly coupled and synchronized dynamical regimes. We also model a partial deafferentation of the neuronal population characteristic for hearing impairment and compare the impact of acoustic CR neuromodulation to noisy stimulation.

Results: We show that both, direct electrical and sensory CR neuromodulation can lead to very similar desynchronizing and anti-kindling effects. CR neuromodulation restores a physiological pattern of synaptic connectivity and leads to a long-lasting desynchronized neuronal firing which is maintained after the stimulation is switched off. In contrast, strong noisy acoustic stimulation can up-regulate the connectivity and induce a pathologically synchronized state, which resembles e.g. the effect of a tinnitus-inducing noise trauma.

Conclusions: Synaptically-mediated, sensory, e.g., acoustic CR neuromodulation can be at least as robust as direct electrical CR. Unlike noisy stimulation, CR neuromodulation reliably enables an unlearning of pathological synchrony and connectivity.

P38. TRANSCRANIAL DIRECT CURRENT STIMULATION (TDCS) INDUCES SHORT- AND LONG-LASTING OF IMPROVEMENT OF TINNITUS INTENSITY AND DISCOMFORT: EVIDENCES FROM ADDITIONAL RECRUITMENT

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Introduction: It is currently admitted that the persistence of tinnitus relies on the development of a maladaptive plasticity of activity in the cortical areas and subcortical structures involved in auditory perception and/or in the limbic system. The hallmark of this maladaptive plasticity is an abnormal activity/excitability of the involved structures. Using transcranial direct current stimulation (tDCS) to modulate brain excitability, we induced short- and long-lasting improvement of tinnitus intensity in 20 patients1.

Aim: To confirm our previous findings1 by recruiting additional tinnitus patients.

Patients & Methods: 13 additional patients suffering from chronic intractable tinnitus were recruited. Anodal, cathodal and sham tDCS (1 mA, 20 min), were applied over the left temporoparietal area (LTA) in a cross-over, placebo-controlled, double-blind trial (2 weeks interval between sessions). Tinnitus intensity and discomfort were assessed by Visual Analogic Scale (VAS) change-scales immediately and one hour after tDCS.

Results: In the pooled group (n=33), after anodal tDCS compared to sham tDCS, the intensity of tinnitus was decreased immediately (p=0.008) and one hour later (p=0.015), and the discomfort was decreased immediately: p=0.034 (one hour: not statistically significant). The immediate positive responders' rate (positive feeling after anodal or cathodal tDCS) was 42 %. Moreover, 52 % of the patients reported longer-lasting effects (improvement, deterioration, and/or various changes in tinnitus characteristics).

Conclusions: After including 13 additional patients with intractable tinnitus, we confirm that anodal tDCS applied over the LTA may have a short and a long-lasting therapeutic impact on both tinnitus intensity and discomfort.

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P39. PALATAL MUSCLE RESECTION FOR INTRACTABLE PALATAL MYOCLONUS CAUSING TINNITUS

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Background: Palatal myoclonus (PM) is an uncommon disorder which shows rhythmic involuntary movement of the muscles of soft palate and causes objective tinnitus. Although various kinds of medicines has been tried to relieve or cure the PM, some of the patients with the PM need adjunctive treatment including injections of botulinum toxin to soft palate. However, the action time of Botulinum toxin is limited, repeated injection has been recommended for recurrent or refractory cases of the PM.

Materials and Methods: Palatal muscle resection (PMR) is the procedure partially removing the muscles of soft palate (uvular muscle, levator veli palatini muscle, and palatoglossus muscle) submucosally. We authors had operated 16-year-old high school boy with intractable objective tinnitus due to essential PM, who received 4 times of Botulinum injection to soft palate.

Results: After the PMR, the objective tinnitus of the patient dramatically reduced and the patient could go back to the study.

Conclusion: PMR might be an excellent option for patients with intractable subjective tinnitus due to palatal myoclonus.

P40. AUTOLOGOUS CARTILAGE INJECTION FOR THE PATULOUS EUSTACHIAN TUBE

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Introduction: The eustachian tube (ET) is normally closed, but it opens temporarily during swallowing. Patients with a patulous ET (PET) suffer from various aural symptoms, such as aural fullness, autophony, and hearing their own breathing. These symptoms are caused by abnormal transmission of sound from the pharynx to the middle ear via an open ET with little attenuation. The diagnosis of PET can be confirmed by visualization of medial and lateral movements of the tympanic membrane coincident with

forced nasal breathing. Numerous medical and surgical treatments have been reported for PET. We introduce a novel injection technique for the treatment of PET using autologous cartilage.

Patients and Methods: We decided to use autologous cartilage injection for the treatment of intractable PET in 25 patients (33 ears). Under local anesthesia, cartilage was harvested from the tragus and cut into small pieces using a scalpel and scissors, so that it could pass through a 19-gauge needle. A Bruning injector syringe was filled with 0.7 mL of the paste-like minced cartilage. We injected the cartilage submucosally into the superior and posterior aspects of the nasopharyngeal ET orifice using a 30-degree, 4-mm nasal endoscope.

Results: Average follow-up periods are 17.2 months. 24 ears (72%) achieved symptomatic relief. Temporary otitis media with effusion was seen in one ear, but no other complications have been observed.

Conclusion: This procedure is minimally invasive and straightforward. Autologous cartilage graft is well tolerated and may be effective material for volumetric augmentation on PET.

P41. EFFECTS OF MEMANTINE ON CHRONIC TINNITUS INDUCED BY ACOUSTIC TRAUMA IN RATS

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Background: Subjective tinnitus is a chronic neurological disorder in which phantom sounds are perceived. Increasing evidence suggests that tinnitus is caused by neuronal hyperactivity in auditory brain regions. One drug investigated for the treatment of tinnitus has been the uncompetitive N-methyl-D-aspartate (NMDA) receptor antagonist, memantine, although the evidence relating to it has been unconvincing to date.

Materials and Methods: Sixteen male Wistar rats were divided into acoustic trauma (n = 8) and sham control (n = 8) groups. The acoustic trauma consisted of a 16 kHz, 110 dB pure tone exposed unilaterally for 1 h under anaesthesia. The behavioural signs of tinnitus were measured by a conditioned lick suppression paradigm at 2 weeks after acoustic trauma and during the drug treatment period. Vehicle or memantine (5 mg/kg, s.c.) was administered once a day for 18 days.

Results: Acoustic trauma resulted in a significant decrease in the suppression ratio (SR) compared to sham controls in response to 32 kHz tones, but not broadband noise or 10 kHz tones, in pre-drug and vehicle control testing (P = 0.02 and 0.009, respectively). Memantine significantly reversed the frequency-specific decrease in the SR in the acoustic trauma group.

Conclusion: Memantine may reduce tinnitus caused by acoustic trauma.

P42. ANTIOXIDANT TREATMENT IN NOISE-INDUCED TINNITUS: A LITERATURE REVIEW AND STUDY PREPARATION

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Background: Noise-induced tinnitus (NIT) is a common symptom after loud music exposure in adolescents and young adults. Mostly, the tinnitus has a transient character. However, symptoms like tinnitus, hyperacusis and hearing loss can become permanent. Research has shown that oxidative stress plays an important role in the pathogenesis of NIT and noise-induced hearing loss (NIHL). Therefore, the preventive use of antioxidants might protect against noise-induced tinnitus. The aim of this study was to perform an extensive literature search after which a clinical study can be prepared.

Method: By use of MeSH search terms following databases were used: Pubmed, Web of Knowledge, Web of Science, Ovid, and Clinicaltrials.gov. The literature concerning the prevention of NIT by use of antioxidants is limited. Therefore, the search was expanded to the prevention of NIHL. The search was limited to human studies.

Results: After reviewing all the articles, we came to the conclusion that N-acetylcysteine (NAC) and magnesium have a potentially protective effect for NIT.

Conclusions: A combination of 600mg NAC and 200 mg magnesium will be used in a double-blind placebo-controlled cross-over study. The protective effect against NIT will be assessed in young adults going out and exposing themselves to loud music.

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P43. TINNITUS AFFECTS WHAT AND WHERE PROCESSING

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Introduction: The localisation of sound is one of the most important functions of hearing. Localisation contributes to Auditory Scene Analysis (ASA), the process we use to make sense of our auditory environment. The perception and localisation of tinnitus is hypothesized to involve ASA processing.

Aim: To investigate the spatial and non-spatial auditory processing of participants with and without tinnitus.

Methods: A total of 40 adults participated in this study, 21 had chronic subjective tinnitus, 19 served as a control group. The history and severity of tinnitus was determined using a Tinnitus Case History Questionnaire and the Tinnitus Functional Index (TFI). The subjective perception of spatial hearing was measured using the Speech, Spatial and Quality of Hearing Scale (SSQ). Spatial and non-spatial auditory processing was investigated by analysing the speed of processing during sound detection, sound localisation and frequency discrimination tasks.

Results: The tinnitus group showed a marginally significant slower response speed in the pitch discrimination task

compared to controls. Participants with centrally located tinnitus responded significantly more slowly at all tasks compared with those with peripherally localised tinnitus.

Conclusion: The slower response speed of tinnitus patients in the pitch discrimination task suggests an impaired 'what' pathway of auditory processing. The difference in processing between persons with central and peripheral localised tinnitus suggests that the perceived location of tinnitus may affect auditory detection, localisation and discrimination processing and/or attention.

P44. CORRELATION TYPE OF MASKER NOISE OF THE MINIMUM MASKING LEVEL AND TINNITUS QUESTIONNAIRE IN CHRONIC TINNITUS PATIENTS

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Background: Minimum Masking Level (MML) is a psychoacoustic measurement for evaluating treatment effects in tinnitus patients. Typically a broadband noise is used as masker(1), but until now there is no scientific proof that this is the best method.

Purpose: The aim of this study is to compare the results of the minimum masking level with other possible maskers and to analyse their correlation with the Tinnitus Questionnaire (TQ).

Method: The MML was measured in 66 tinnitus patients with four different maskers: speech noise, white noise, tinnitus frequency and characteristics, frequency of 500 Hz. The MML is expressed in terms of dBHL and dBSL. Furthermore all patients completed the Tinnitus Questionnaire.

Results: There is no correlation between the Tinnitus Questionnaire and MML measured with speech noise and white noise as masking noise. However a correlation was found between TQ and MML measured with masking noise at tinnitus frequency (dBHL) (p=0,008) and at 500 Hz (dBSL) (p=0,001). Nevertheless these correlations are weak (ρ=0,272 and ρ=-0,370).

Conclusions: The MML measured with the different masking noises does not correlate with the TQ. Considering these results, the minimum masking level does not contribute significantly to the evaluation of tinnitus treatment.

Acknowledge: We thank the Stavros Niarchos Foundation for the financial support for tinnitus research.

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P45. EFFECTS OF FREQUENCY DISCRIMINATION TRAINING ON TINNITUS: RESULTS FROM A SERIES OF RANDOMIZED TRIALS

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Background: That auditory perceptual training may alleviate tinnitus draws on two observations: i) tinnitus probably arises from altered activity within the central auditory system following hearing loss, and ii) sound-based training can change central auditory activity. Training that provides sound enrichment across hearing-loss frequencies has therefore been hypothesized to alleviate tinnitus.

Materials and Methods: We tested this prediction with two randomized trials of frequency discrimination training involving a total of 70 participants with chronic subjective tinnitus. Participants trained on either (1) a pure-tone standard at a frequency within their region of normal hearing, (2) a pure-tone standard within the region of hearing loss, or (3) a high-pass harmonic complex tone spanning a region of hearing loss.

Results: Analysis of the primary outcome measure revealed an overall reduction in self-reported tinnitus handicap after training that was maintained at a one-month follow-up assessment, but there were no significant differences between groups. Secondary analyses also report the effects of different domains of tinnitus handicap on the psychoacoustical characteristics of the tinnitus percept (sensation level, bandwidth, and pitch) and on duration of training.

Conclusions: Our overall findings and conclusions cast doubt on the superiority of a purely acoustic mechanism to underpin tinnitus remediation. Rather, the non-specific patterns of improvement are more suggestive that auditory perceptual training affects impact on a contributory mechanism such as selective attention or emotional state. In our now ongoing third trial (60 participants) we are testing the effect of different training platforms and have included attention as an outcome measure.

P46. NO EFFECT OF TINNITUS INTENSITY AND DISTRESS ON SPEECH IN NOISE RESULTS IN SINGLE-SIDED DEAF PATIENTS

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Background: Reduced speech recognition in background noise is one of the main complaints of patients with unilateral sensorineural hearing loss (SSD). The presence of tinnitus is often mentioned as an additional burden in difficult listening conditions.

Purpose: To find out whether the tinnitus intensity in the deaf ear influences the speech in noise results (SPIN) of the contra-lateral normal hearing ear.

Material and methods: 59 single sided deaf patients were included in this study. Tinnitus intensity assessment was done with a visual analogue scale (VAS) and tinnitus distress was measured with the Tinnitus Questionnaire (TQ). Patients were categorized in the no tinnitus group (GRI:N=18), non-incapacitating tinnitus group (GRII:N=16) (TQ grade 1-2) and the incapacitating group (GRIII:N=25) (TQ grade 3-4). Mean PTA at 0.5, 1, 2 and 4 kHz was 17,03dBHL at the better hearing side (GRI 17.5dBHL - GRII 16dBHL- GRIII 17.3 dBHL). Mean duration of hearing loss was 6.13 years (GRI 4.78y - GRII 7.13y- GRIII 6.46y).

Adaptive speech in noise testing was performed using the LIST sentences in free field (0° azimuth).

Results: The mean speech reception threshold in these patients was -4dBSPL (GRI -3.54 dBSPL - GRII -4.86dBSPL- GRIII -3.78dBSPL). The self-rated level of tinnitus (VAS) and of tinnitus distress (TQ) did not have a predicting value concerning speech in noise scores in these SSD patients when controlling for contralateral hearing loss and age (p = 0.534, p=0.634).

Conclusions: Perceived tinnitus loudness and tinnitus distress do not influence speech understanding in noise with the contralateral ear in patients with profound unilateral sensorineural hearing loss.

P47. RESULTS OF OTOACOUSTIC EMISSIONS AND EFFERENT SUPPRESSION IN SUBJECTS WITH CHRONIC TINNITUS AFTER NOISE EXPOSURE DURING RECREATIONAL ACTIVITIES

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Introduction: Noise exposure can cause noise-induced hearing loss (NIHL) as well as tinnitus. NIHL damages primarily the outer hair cells in the cochlea. Therefore, otoacoustic emissions (OAEs) could provide valuable information regarding the cochlear status in subjects with tinnitus. OAEs with contralateral acoustic stimulation can be used to evaluate the efferent auditory system.

Aims: The aim of the study was to compare the results of OAEs and efferent suppression (ES) in subjects with chronic tinnitus due to recreational noise exposure with control subjects.

Patients and methods: The hearing status of 11 ears in each group was evaluated by admittance measures, pure tone audiometry, transient evoked OAEs (TEOAEs), distortion product OAEs (DPOAEs) and ES.

Results: First, the number of present TEOAEs or DPOAEs at most frequency bands was lower in the tinnitus group as compared to the control group. Second, the mean amplitudes of TEOAEs, DPOAEs and ES in subjects with tinnitus was smaller than in the control group. Moreover, there were statistically significant differences in TEOAE amplitudes at 1.0 and 4.0 kHz, and DPOAE amplitudes at 1.5 kHz.

Conclusion: Literature concerning TEOAEs, DPOAEs or ES in subjects with tinnitus is inconclusive. The current study found decreased TEOAE and DPOAE amplitudes and ES in subjects with chronic tinnitus after recreational noise exposure as compared to the control group. OAEs can therefore be used as an objective evaluation of the cochlear hearing status in subjects with tinnitus. The role of the efferent auditory system in subjects with tinnitus should further be explored.

P48. COMBINING "TAILOR-MADE NOTCHED MUSIC TRAINING (TMNMT)" WITH LEFT AUDITORY CORTEX TDCS: AN EXPLORATIVE STUDY

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Background: In previous studies, we have shown that "tailor-made notched music training (TMNMT)" is an effective treatment for patients suffering from chronic tonal tinnitus. TMNMT intends to attract inhibition to neuronal populations involved into tinnitus generation, in order to alleviate tinnitus perception. In this study, based on the idea that tDCS could "open the door for plasticity", we combined TMNMT with tDCS over left auditory cortex, in an effort to further increase the efficacy of short-term TMNMT.

Materials and Methods: We treated 30 patients suffering from chronic tonal tinnitus with TMNMT over the course of 10 subsequent days (2.5 hours training per day, 25 hours in total). Additionally, during the initial 5 days of TMNMT and during the initial 30 min of listening to the training music, the patients simultaneously received tDCS over the left auditory cortex (anodal (N = 10) vs. cathodal (N = 10) vs. sham (N = 10); current strength: 2 mA). As outcome variables, in order to assess treatment efficacy, we used different measures of tinnitus loudness and tinnitus-related distress.

Results: The preliminary results indicate that the combination of TMNMT and tDCS over left auditory cortex is an effective treatment, which is able to reduce tinnitus-related distress.

Conclusions: Based on the findings, it appears worthwhile to further explore the potential of the combined TMNMT – tDCS treatment for chronic tonal tinnitus.

P49. TINNITUS AND NORMAL HEARING - A STUDY OF 175 CASES

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Introduction: Due to our actual knowledge tinnitus in most cases results from abnormal neural activity elicited at any level of auditory pathways and is interpreted in auditory cortex as a perception of sound, which is not accompanied by any mechanic activity within the cochlea. Tinnitus patients usually present various degrees of cochlear dysfunction, which can be manifested as sensorineural hearing loss, loudness intolerance, a distinct decrease of the DPOAE amplitude, recruitment or abnormal efferent reduction of OAEs through contralateral acoustic stimulation. But 8-15% of tinnitus patients present normal audiometric profiles. In these patients the mechanism of tinnitus generation remains unclear.

Aim of the study: The aim of the study was to assess DPOAE levels and EHF thresholds in tinnitus subjects with normal hearing and compare the data with those from a normally hearing control group without tinnitus, in order to evaluate if any detectable high frequency cochlear dysfunction might be responsible for the tinnitus generation.

Material and methods: 175 tinnitus patients (group 1 – tinnitus in left ear - 47 patients, group 2 – tinnitus in right ear – 23 patients, group 3 – bilateral tinnitus – 105 patients) and 60 controls (group 4). Inclusion criteria: age up to 40, normal otoscopic examination, type A tympanometry, normal hearing (up to 20 dB) in PTA (250-8000 Hz), no loudness intolerance, constant tinnitus for at least 6 months of stable localization (site of tinnitus has not changed from the previous localization).

In each patient high frequency audiometry (at 10, 12.5, 14 and 16 kHz) and DPOAE registration (L1=65 dB SPL, L2=55 dB SPL, f2/f1= 1.2, S/N≥3 dB) were performed. Then statistical analysis was applied for comparison between left and right ears in the same group and also across different group of patients.
Results: statistically significant differences were observed mainly in unilateral tinnitus group. These differences were more evident in audiometric data than DPOAE data. Left-sided tinnitus was twice more frequent than right-sided tinnitus. Few statistically significant differences were found between bilateral tinnitus group and controls.
Conclusions: Unilateral tinnitus in normally hearing individuals may be caused by the damage of the basal region of the cochlea. There is greater incidence of high frequency hearing loss (above 8 kHz) in the ear with tinnitus in comparison to control group. In unilateral tinnitus group, the organ of Corti at the site of tinnitus is more seriously damaged than in the opposite ear. The asymmetry of cochlear damage may be crucial for tinnitus lateralization. Bilateral tinnitus, more frequently than unilateral one, can result from other pathologies, not connected with the organ of Corti.

P50. SPATIAL & TEMPORAL PERCEPTION

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Background: Tinnitus may hinder various hearing abilities. However, it is unknown whether tinnitus can affect sound localization and temporal resolution. This study was aimed to investigate 1) whether tinnitus affects sound localization ability (spatial perception) and 2) whether tinnitus affects gaps-in-noise (GIN) performance (temporal perception).

Materials and Methods: Prospective controlled study. 1) Sound localization test was applied to 40 tinnitus patients (unilateral 26, bilateral 14) and 40 age-hearing-matched normal controls with 7 speakers positioned in a semicircle (radius 1m) on the horizontal plane at 30-degree intervals. The error score was calculated by scoring 1 point for each 30 degrees of difference between the stimulus-presenting speaker and the speaker identified by the subject. 2) GIN test was performed in 60 unilateral tinnitus patients with symmetric hearing threshold. Comparisons were made between the results of GIN test (white noise, 50 dB sensation level) of tinnitus side and non-tinnitus side.

Results: 1) The mean total error score of sound localization test of the tinnitus group (18.8±9.2) was significantly higher than that of the control group (13.1± 7.5) ($P < .05$). The significantly higher error score was revealed when the sound was presented to the tinnitus side than to the contralateral side. 2) Neither the average of GIN thresholds nor the mean percent correct in tinnitus ear was different from those in non-tinnitus ear.

Conclusions: Tinnitus interferes with spatial perception especially when localizing sound stimuli is presented to the tinnitus side, whereas unilateral tinnitus does not influence the auditory temporal perception.

P52. NANOTHERANOSTICS: APPLICATION TO TINNITUS RESEARCH

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Background: While effective pharmacological agents suitable for the treatment of tinnitus may exist, targeting and drug delivery mechanisms remain sub-optimal. To improve treatment efficacy, we describe an approach using custom fabricated encapsulated manganese nanoparticles in combination with magnetic resonance imaging (MRI) to identify tinnitus related neural activity and serve as a device for drug delivery. We hypothesize that nanoparticles capable of housing manganese ions for MRI contrast enhancement, binding target-specific receptors, and releasing appropriate therapeutic agents in tinnitus positive brain areas, will improve treatment outcomes for individuals with tinnitus.

Materials and Methods: Optimization for successful targeting of tinnitus related neuronal activity in the brain requires that Mn-based nanoparticles be MRI-active, small (<100 nm), have colloidal stability in aqueous environments, allow for surface functionalization of specific targeting moieties (receptor ligands), and support conjugation and/or entrapment of therapeutic compounds. Successful targeting will be quantified and spatially localized by measuring manganese in specific brain regions by MRI. Bio-inspired synthesis routes using proteins and nucleotides will allow for the fabrication and delivery of nanoscale-based organic/inorganic hybrid materials in an effective manner.

Results: Organic based nanoparticles were created that are small, stable, biocompatible, support both conjugation to specific targets and entrapment of pharmaceutical agents and are detectable by MRI.

Conclusions: Development of this novel theranostic platform provides the opportunity to target tinnitus positive brain areas and deliver a payload of drugs to abate this condition.

Functional Imaging

P53. LESSONS FROM TWO ALE META-ANALYSES OF PET STUDIES ON TINNITUS AND COCHLEAR IMPLANT

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Background: Positron emission tomography (PET) studies, together with other imaging modalities, have shown functional changes not only in the auditory cortex but also in non-auditory regions such as limbic, frontal, and parietal areas in tinnitus. Nonetheless, disparities in task dimension, low statistical power, and intrinsic uncertainty of indirect activity measurement limit comprehensive understanding. We performed an ALE meta-analysis of PET studies on

tinnitus to retrieve the most consistent activation areas and to compare the results with those from other imaging modalities. Moreover, by comparison to another meta-analysis on cochlear implant (CI) patients, we attempted to find commonly activated regions.

Materials and Methods: We performed two ALE meta-analyses for 10 studies on tinnitus and 8 studies on CI.

Results: The most consistently activated regions in tinnitus subjects were the left primary- (A1) and bilateral secondary auditory cortices (A2), left middle- and bilateral inferior temporal gyri (ITG), left parahippocampal area, left geniculum body, left precuneus, right anterior cingulate cortex, right claustrum, right middle- (MFG) and inferior frontal gyrus, and right angular gyrus (AG). Most of the brain found in this meta-analyses replicate previous findings of qEEG or MEG studies When compared to the results in CI patients, the bilateral A1/A2, bilateral ITG, right MFG, and right AG were commonly activated.

Conclusion: This study proves PET is useful for tinnitus research and solidifies human tinnitus research itself by confirming previously described brain areas in qEEG/MEG studies. Moreover, the areas commonly activated in both meta-analyses may be future targets for further research.

P54. CHANGES OF OSCILLATORY ACTIVITY IN THE TINNITUS NETWORK AND RELATED TINNITUS RELIEF INDUCED BY CR NEUROMODULATION

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Background: Subjective tinnitus is associated with enhanced neuronal synchronization and is associated with an increase in delta and gamma and a decrease of alpha power in specific auditory and non-auditory brain areas. We here study (i) how the acoustic CR neuromodulation1 induced EEG changes compare to healthy controls, and (ii) whether these changes correlate to clinical improvements.

Materials and Methods: 12 weeks of CR therapy with 4-6h/day resulted in a pronounced reduction of tinnitus symptoms1. Spontaneous EEG recordings were performed in tinnitus patients (n=28) at baseline and after 12 weeks of CR therapy and in a control group (n=16) of healthy tinnitus-free subjects. EEG was investigated by using the BESA source montage and sLORETA. The relationship between changes in power spectra and clinical scores was investigated using a Partial Least Squares regression.

Results: Spectral power in delta, low theta, high beta and gamma bands was significantly enhanced in tinnitus patients as opposed to controls. After 12 weeks of acoustic CR neuromodulation the EEG spectrum of the tinnitus patients approached the average spectrum of the control group with the most prominent CR-induced changes in temporal regions. In addition, we found a positive association between changes in delta and gamma power and changes in TQ/VAS scores.

Conclusion: The pronounced reduction of tinnitus symptoms after 12 weeks of CR therapy is associated with a reversal of tinnitus-related low alpha and pathologically enhanced gamma/delta power in auditory and non-auditory brain areas. Strongest CR-induced reversal of abnormal oscillatory activity was found in temporal regions.

1 Tass PA et al., Restor. Neurol. Neurosci. 30 (2012)

P55. DECREASED EVOKED BRAIN ACTIVITY IN LEFT AUDITORY CORTEX OF TINNITUS SUBJECTS DURING ATTENTIONAL TASK PERFORMANCE

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Background: Tinnitus patients often report having concentration and attention problems. Previous studies have shown decreased task performance in challenging tasks. To investigate the underlying neural mechanisms, the present functional magnetic resonance imaging (fMRI) study comprised a task that required directing attention to auditory or non-auditory stimuli in the presence of distractors.

Materials and Methods: 16 tinnitus patients and 16 controls, matched in age and hearing loss, underwent two fMRI sessions that comprised a 1-back task, involving the detection of repeating letter stimuli. Various types of distractors (e.g. concordant or discordant) were presented in the same or other modality (auditory or visual). Response accuracy and reaction times were recorded. Region of interest (ROI) analyses were performed to measure and compare brain activation for all task conditions.

Results: Behaviorally, the subjects' accuracy significantly depended upon the type of distractor, but not its modality. Conversely, reaction times depended upon distractor modality, but not type. For both measures, the tinnitus group did not significantly differ from controls. Regarding brain activity, all conditions involving distractors evoked stronger responses in sensory cortex than those without distractors. Stimulus-evoked activity tended to be diminished in tinnitus subjects in auditory and visual cortex; the difference was significant for left auditory cortex only. Task-related effects in other areas (e.g. premotor, frontal) were not significantly different.

Conclusions: Although we found no differences in task performance in tinnitus patients compared to controls, stimulus-evoked activation differed in left auditory cortex. Our results indicate tinnitus-related abnormalities in sensory processing, but not cognitive function.

P56. INVERSE CORRELATION OF TINNITUS LOUDNESS AND HEARING IMPAIRMENT WITH GAMMA-BAND POWER

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Background: Previous studies reported increased gamma, delta and theta power together with decreased alpha band power in tinnitus patients. We studied the association of these electrophysiological markers with audiological tinnitus characteristics, tinnitus-related distress, hearing impairment, and psychological-psychiatric comorbidities.

Materials and Methods: In 46 males frequency composition of the tinnitus was reconstructed and mean hearing loss (MHL) between 0.125 and 16kHz was determined. Minimum masking levels (MML) and tinnitus-related distress were determined, and all completed the Symptom Checklist-90-R (SCL-90-R). Resting EEG was recorded with 22 electrodes. Data were pre-processed and analyzed offline with MATLAB and power spectra were estimated by a multi-taper method. Correlations between spectral power and the factors named above were computed.

Results: Significant increase of gamma band power with increasing tinnitus loudness was apparent when controlling for MHL and global distress SCL-90-R scores, whereas gamma, beta and alpha band power decreased significantly with MHL when controlling for age, tinnitus loudness, and SCL-90-R. Increase in delta band power correlated significantly with increasing MML controlled for age and MHL. An ANOVA revealed a significant difference in theta band power between patients with low and high tinnitus-related distress.

Conclusions: Results suggest that gamma oscillations represent the brain activity correlate of the tinnitus percept whereas theta oscillations are associated with tinnitus-related distress. Reduction of gamma with hearing impairment implicates that gamma oscillations do not necessarily result in tinnitus but that a concomitant reduction of alpha activity may be necessary to promote continued gamma oscillations that give rise to a tinnitus.

P57. AN FMRI STUDY OF EMOTIONAL PROCESSING IN TINNITUS USING AFFECTIVE SOUNDS

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The aim of the study was to determine differences in the engagement of the emotional processing network in individuals with tinnitus relative to those without tinnitus. Our hypothesis was that tinnitus causes an impaired emotional response to affective auditory stimuli. Previous research has shown that an impaired limbic-auditory link may influence tinnitus persistence. Therefore, any disruption in the limbic system should be reflected in emotional processing. We conducted a functional magnetic resonance imaging (fMRI) study using a 3T Siemens Allegra MRI head-only scanner. We collected fMRI data from 11 subjects with hearing loss and mild tinnitus (TIN), and 7 age- and gender-matched controls with normal hearing and without tinnitus (NH). Participants from both groups rated stimuli from the International Affective Digital Sounds (IADS) database as (a) pleasant (e.g., people laughing), (b) unpleasant (e.g., people fighting), or (c) neutral sounds (e.g., footsteps). Similar activation patterns for pleasant and unpleasant stimuli were observed; therefore the stimuli were grouped into the 'emotion' category. The NH group showed increased response in limbic regions, including the anterior cingulate, parahippocampal gyrus and cingulate gyrus when comparing emotional to neutral sounds. In contrast, TIN subjects exhibited greater frontal involvement for the same contrast, suggesting greater top down control of emotional processing in individuals with tinnitus relative to those without tinnitus. The TIN, but not the NH, group showed extensive response to the neutral sounds relative to the emotion sounds in medial temporal and inferior frontal gyri, suggesting that individuals with tinnitus may exhibit hyper-responsiveness to neutral sounds.

P58. CENTRAL ACTIVITY IN A YOUNG TINNITUS POPULATION: A QEEG ANALYSIS

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Background: Electroencephalography (EEG) is a frequently used technique to study generating networks of tinnitus. The objective of the present retrospective study was to analyze source localized resting state EEG activity in young tinnitus patients.

Method: Data of a group of young adults (N = 42) aged 15 to 22 years old (Mean age= 19.5) suffering from tinnitus was analyzed. Patients underwent full ENT investigation, audiological testing (audiometry, impedance testing and tinnitus analysis) and resting-state EEG. The EEG results of the tinnitus patients were compared to a normative group (N = 42), homogeneous for age and sex. In addition, the tinnitus group was compared to an older tinnitus group (N = 42) homogeneous for sex, hearing loss and tinnitus type.

Results: Young adults experiencing tinnitus showed increased beta1 and beta2 activity in the dorsal anterior cingulate cortex (dACC) in comparison to the control group. Compared to the older group (Mean age = 54.56), young adults showed a decrease in gamma activity in the auditory cortex as well as an increase of beta2, beta3 and theta synchronized activity in the supplementary motor area (SMA).

Conclusions: As the dACC is part of an emotional-related area, the increased synchronization in the beta1 and beta2 frequency band in young adults with tinnitus is likely due to the tinnitus related distress in the tinnitus group. Brain activity differences between the younger and older group might be due to a difference in the conscious perception of the phantom sound and to changes of the local and global networks due to aging.

Acknowledgements: We thank the Stavros Niarchos Foundation for the financial support for tinnitus research.

P59. FACTORS AFFECTING ELECTROPHYSIOLOGICAL CORRELATES OF TINNITUS

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Electrophysiological correlates of tinnitus have been examined using the stimulus-driven 40-Hz steady state response (ASSR) and the N1 transient response localizing to primary and nonprimary auditory cortex, respectively. Results have not been consistent across laboratories, however, likely owing to distinctive properties of these response and variables that affect them. We are taking two approaches. In one approach, the sound level of stimulus probes presented to the tinnitus frequency region (TFR) is adjusted by each subject to match the loudness of a 1 kHz sound at 65 dB SL (in the range of normal hearing). This procedure may control perceived sound intensity when recruitment and hearing loss are present in the TFR. With this method we found in two cohorts that ASSR amplitude was reduced and N1 amplitude enhanced in tinnitus compared to age and hearing level matched controls, when probe frequency was in the tinnitus frequency region (TFR, 5.0 kHz). When probe frequency was below the TFR (0.5 kHz) both responses were enhanced in tinnitus. The results

implicate changes in the TFR of A1 in tinnitus. A second approach currently under development measures behavioural, ASSR and N1 loudness growth functions (LGFs) in subjects with tinnitus and in age and hearing level matched controls for sounds in the TFR (5.0 kHz, other) and below this region (0.5 kHz). This approach may permit comparisons of EEG responses across intensities with and without tinnitus using different sound level metrics. Intrinsic properties of ASSRs that affect such comparisons are discussed. (CIHR and NSERC Canada)

FRIDAY
JUNE 15, 2012

9:00 - 10:30 a.m.
PLENARY TALKS

9:00 - 9:45 a.m. – Keynote Speaker
NEURAL SYNTAX: WHAT DOES MUSIC OFFER TO NEUROSCIENCE (AND VICE VERSA)

György Buzsáki
György Buzsáki is a Board of Governors Professor of Neuroscience at Rutgers University. His primary interests are brain oscillations, sleep and memory. With more than 200 papers published on these topics, he is among the top 250 most-cited neuroscientists. Dr. Buzsáki is a Fellow of the American Association for the Advancement of Science, an honorary member of the Hungarian Academy of Sciences and author of the popular book "Rhythms of the Brain". In 2011 he won the 'Brain Prize', awarded to one or more scientists who have distinguished themselves by an outstanding contribution to European neuroscience. In view of the recently suggested involvement of the hippocampus in tinnitus, his contribution on hippocampal function will enlighten tinnitus researchers. Innovation in science will meet innovation in art when György Buzsáki debates with Belgian innovative artist of international stature Jan Fabre.

Brain activity is in perpetual change. Such changes are present at the level single neurons, neuronal assemblies and neural networks. The time-dependent variations of such changes can be quantified (by reocording from populations of neurons or, non-invasively, from the scalp) and characterized. The spectral qualities of such patterns reveal a 1/f relationship – in the language of engineering brain patterns belong to a special category of noise: 'pink' noise. Pink noise is special because of its fractal nature and because it is halfway between absolute predictability (e.g., perfect rhythm) and white (or random) noise or between certainty and absolute uncertainty.

All music, quantified this way, is pink noise, perhaps because it is both generated and perceived by brains. Music is characterized by the temporal overlap of many instruments, much like cell assembly patterns in the brain. The temporal overlap is special because of its correlational structure: short-term correlations are related to longer correlations in both music and brain activity, thereby providing first order and higher order relationships.

I hypothesize that the esthetic features of music arise from its pink-noise nature because brain dynamics are tuned to this mid-level certainty versus uncertainty. Esthetic pleasure generated by music arises when from the short-term correlations the brain can guess/predict what can possibly come next. This definition may also explain why appreciation of more and more complex music structures require extensive training, since such learning process expands the brain's ability to predict higher order relationships from simpler correlations.

9:45 - 10:30 a.m. – Invited Speaker
NEUROPHYSIOLOGICAL ASPECTS ON MISOPHONIA, PHONOPHOBIA, HYPERACUSIS AND EXPLODING HEAD SYNDROME

Aage R. Møller
Aage R. Møller is Professor of Cognition and Neuroscience and MF Jonsson Endowed Chair in the School of Behavioral and Brain Sciences at the University of Texas at Dallas. He is a living legend in the tinnitus field. Born in Denmark, he received a PhD in Medical Sciences in the famous Karolinska Institute in Sweden. He subsequently moved to the United States. He has written more than 200 peer reviewed scientific papers, more than 100 book chapters, 13 single author books and was editor or co-editor of 9 multi-author books. The Textbook of Tinnitus was has most recent brain child in the domain of tinnitus. He founded and was editor in chief of Hearing Research for 27 years. He is currently chairman of the Board of Directors of the Tinnitus Research Initiative. His main interest is brain plasticity related to tinnitus, hyperacusis and phonophobia as well as pain.

When evaluating or treating tinnitus the focus is often on the perception of the phantom sound that has given the disorder its name. However, most forms of tinnitus also have a second symptom in addition to hearing a phantom sound. This symptom can be in the form of eliciting fear from certain sounds that reach the ear (phonophobia), making normal sounds intolerable (hyperacusis) or it can be making specific sounds intolerable (misophonia). The exploding head phenomenon is probably the least known of the symptoms that may accompany tinnitus. While the perception of the tinnitus may be disturbing or annoying; the effect on a person of these other symptoms can be as severe or worse. (Margaret and Pawel Jastreboff described misophonia in 2001). It is the least understood of the symptoms that may accompany tinnitus. Typically, misophonia is a strong dislike of sounds produced when eating and chewing and which elicit an unpleasant effect that often is difficult to describe. These accompanying symptoms to tinnitus may reduce the quality of life more than the tinnitus, yet the focus is often on the intensity of the tinnitus, which is often used as a measure of the severity of a person's tinnitus. Despite the effect of these accompanying symptoms on a person's quality of life is often greater than that of the tinnitus itself, treatment of tinnitus is often focused on the perception of the tinnitus. Treatments are often evaluated on the basis of their ability to reduce the perception of the tinnitus, not the effects of the accompanying symptoms. Little is known about the neurophysiological bases for these accompanying symptoms but it seems likely that they may be caused by abnormal connections in the brain allowing sound evoked neural activity to be routed to neural circuits in the "emotional" brain. Subcortical connections from the dorsal-medial thalamus to structures of the "emotional brain" may be strengthened causing an abnormal involvement of the amygdala, the anterior cingulate and perhaps the insula lobe. This may explain phonophobia and it seems likely that misophonia involves the insula in an abnormal way. Some of these symptoms may involve misinterpretations of sounds. Changes in connections may be caused by maladaptive plastic changes. Reversing these changes by "unlearning" may be an effective treatment for some of the symptoms that often accompany tinnitus.

10:45 a.m. - 12:45 p.m.

SESSION 5: Treatment
Chair: Michael Kilgard

Room: Morus

SOUND THERAPY PLUS TRANSCUTANEOUS VAGUS NERVE STIMULATION IN THE TREATMENT OF PATIENTS WITH TINNITUS.

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Background: Recent studies suggest that a combination of sound therapy (ST) and vagus nerve stimulation (VNS) may reverse maladaptive neuronal plasticity and associated tinnitus. In this pilot study, we examined the effects of ST and tVNS in 15 patients with tinnitus. In addition, the effects of tVNS on auditory cortical activation were examined with magnetoencephalography (MEG) in eight patients with tinnitus.

Methods: All the patients were examined by standard otologic methods and comprehensive tinnitus tests.The acute effect of tVNS was evaluated by using the WHO well-being index. In the MEG study N1m responses around 100 ms after the onset of probe stimuli were registered in the presence/absence of tVNS. tVNS was delivered at 25 Hz rate to the left tragus. The auditory probe stimulus was presented at tinnitus frequency at comfortable loudness. The tVNS-related artifact was removed with spatiotemporal signal space separation (tSSS) algorithm from the MEG data. Equivalent current dipoles (ECD) where then fitted to the auditory N1m responses. The N1m wave was analyzed in terms of source level amplitude and latency.

Results: The ST/tVNS produced increased scores in the WHO wellbeing test, indicating improved mood. The application of tVNS decreased the amplitude of the auditory N1m response. The tVNS effect could be observed in both cortical hemispheres.

Conclusions: Auditory cortical activation was modulated by the application of tVNS, suggesting an access to the auditory system through the vagus nerve. Thus, tVNS may have the potential of reducing aberrant activity in the auditory tract that is thought to be associated with tinnitus. The ST/tVNS seems to reduce the distress which often is the major problem in tinnitus patients.

OPTIMIZING VNS-DIRECTED NEURAL PLASTICITY FOR THE TREATMENT OF CHRONIC TINNITUS

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[2] *TRI Tinnitus Clinic, BRAI²N & Department of Neurosurgery, University Hospital Antwerp, Belgium.*

Pathological neural plasticity plays a major role in the genesis and maintenance of chronic tinnitus. Reversal of aberrant plasticity is therefore a promising approach to the treatment of tinnitus. We have developed a novel method to direct highly specific and long lasting neural plasticity. Brief bursts of vagus nerve stimulation (VNS) trigger release of neuromodulators that direct brain changes specific to associated neural activity patterns. Pairing VNS with tones is sufficient to powerfully shape responses in the central auditory system. We have demonstrated that this therapy can be therapeutic in an animal model of tinnitus and in human patients. We are now optimizing the clinical parameters through parallel studies in humans and preclinical studies in animals. VNS-directed plasticity is sensitive to the current used to activate the vagus nerve, to the interval between VNS-tone pairings, and to the behavioral state of the individual during therapy. We will present evidence suggesting that with further study VNS-directed plasticity may be optimized to become a reliable, safe, and long-lasting therapy for chronic tinnitus.

Background: Pathological neural plasticity plays a major role in the genesis and maintenance of chronic tinnitus. Reversal of aberrant plasticity is therefore a promising approach to the treatment of tinnitus.

Materials and Methods: We have developed a novel method to direct highly specific and long lasting neural plasticity. Brief bursts of vagus nerve stimulation (VNS) trigger release of neuromodulators that direct brain changes specific to associated neural activity patterns.

Results: Pairing VNS with tones is sufficient to powerfully shape responses in the central auditory system. We have demonstrated that this therapy can be therapeutic in an animal model of tinnitus and in human patients. We are now optimizing the clinical parameters through parallel studies in humans and preclinical studies in animals. VNS-directed plasticity is sensitive to the current used to activate the vagus nerve, to the interval between VNS-tone pairings, and to the behavioral state of the individual during therapy.

Conclusions: We will present evidence suggesting that with further study VNS-directed plasticity may be optimized to become a reliable, safe, and long-lasting therapy for chronic tinnitus.

PAIRED VAGUS NERVE STIMULATION FOR TINNITUS – PILOT STUDY RESULTS

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[3] *MicroTransponder Inc., Austin, TX*

Introduction: Vagus nerve stimulation (VNS) paired with tones has shown efficacy in animal studies. This first-in-human pilot study was undertaken to further explore paired VNS for tinnitus.

Patients and Methods: Twelve patients consented; 10 met inclusion criteria and were implanted with a helical electrode wrapped around the left cervical vagus nerve with the lead connector end exiting at an abdominal incision. After implant and recovery, patients returned daily for connection to an external stimulator and therapy sessions (½ second VNS paired with tones every 30 seconds for 2.5 hours) for four weeks. Tones were provided through headphones connected to a laptop running proprietary software. Implanted patients averaged 45.4 years of age (23.7 to 59.5), had tinnitus for 5.6 years (1.2 to 14.0 years), and had tried numerous previous therapies including various medications, trans-magnetic stimulation (TMS) and cortical stimulation (tDCS). Eight patients were male; two were female. All patients had tonal tinnitus.

Results: In general, stimulation was well-tolerated; adverse events were as expected based on other VNS applications. Each Friday patients completed questionnaires and had audiometric testing. Tinnitus Handicap Inventory response was defined as a 30% decrease in score; Iowa Tinnitus Handicap Questionnaire response was defined as a 10-

point decrease; MML response was defined as a 10 dB decrease. At four weeks THI response was 40%; THQ response was 70%; MML response was 60%.

Conclusions: Findings from this pilot study suggest that VNS paired with tones could become an effective therapy for the treatment of tinnitus. Development of a fully implantable device has commenced.

VIRTUAL REALITY EXPOSURE THERAPY FOR UNILATERAL TINNITUS

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Background: We have developed dedicated auditory and visual 3D virtual reality environments in which tinnitus sufferers are given the possibility to voluntarily manipulate an auditory and visual image of their tinnitus. This study examined the data of all participants that were undergoing virtual reality treatment as part of a randomized clinical trial comparing virtual reality therapy and cognitive behavior therapy to a wait list control for the treatment of unilateral tinnitus. The current study utilized data from all individuals who were treated with virtual reality exposure therapy.

Materials and Methods: After a first session devoted to the creation of an acoustic replica of the patient's tinnitus that is further included into the virtual environments, 50 patients have followed 8 sessions of virtual reality. During each session, the patients had a trajectory to follow in a virtual environment in which they had to manipulate an auditory and visual representation of their tinnitus. Presence, cybersickness and state anxiety levels were assessed at each session.

Results: Results of virtual reality treatment on behavioral measures at post-treatment suggest that they generalize to the real world. Cybersickness, anxiety and presence during immersion are important factors for treatment outcome.

Conclusions: Dismantling research methodology is needed to separate the contribution of the various components at stake in this virtual reality treatment. Understanding the processes would help implementing virtual reality into clinical practice given that treatment outcome would be better predictable.

THE EFFECT OF HYPERBARIC OXYGEN TREATMENT (HBOT) ON POST TRAUMATIC CENTRAL-TYPE CHRONIC DISABLING TINNITUS

Shlamkovitch, N.
Assaf Harofeh Medical center, Otolaryngology Head and neck surgery

Objective: To define the effect of Hyperbaric Oxygen Treatment (HBOT) on post traumatic central-type chronic disabling tinnitus

Study Design and Methods: The study was aimed to include patients suffering from post traumatic chronic disabling tinnitus of the central type. Patients were included if they were 1-5 years post the traumatic events. Tinnitus was typed using Tinnitus disabling score questionnaire, a full oto-neurological physical examination, a complete hearing evaluation (including audiometry up to 20,000 Hz, and ABR). A complete Tinnitus matching score and brain SPECT scan for perfusion were performed. The study was a cross-over, randomized trial and patients were randomly assigned to receive HBOT after their first or second evaluation (2 months later). The evaluations were performed at baseline and 2 months after for all. The control group had a third repeated evaluation after the cross mach (≈4 months from baseline), when they have completed the HBOT. The HBOT included 40 sessions of 60 minutes exposure to 100% oxygen at 1.5 Atmosphere pressure, 5 days per week. Except for the tinnitus, dizziness, neuro-cognitive status, quality of life, and brain SPECT scan were also assessed at each of the evaluation points.

Results: Twenty one patients had completed the study protocol. No significant improvement was notice in the control group during the control period. Seven of the patients suffered from prior whiplash injury, 11 from blunt head injury and one from direct blunt injury to the ear. Fourteen out of 21 patients (66%) reported a major improvement of their tinnitus after the HBOT. Six of these patients (21%) reported that the tinnitus ceased completely. All of the patients (100%) reported a significant improvement in their quality of life. Thirteen out of the 18 patients (72%) who also complained of post traumatic dizziness, reported a significant improvement following the treatment. A major cognitive function improvement (NeuroTrax, Mindsteam) was found in 15 out of 19 (79%). An objective brain SPECT scan improvement in brain perfusion was demonstrated in correlation to the improvement in tinnitus.

Conclusions: In patients with chronic post traumatic disabling tinnitus of the central type, HBOT was found to be a useful treatment with about 66%. This is the first study that the demonstrate the favorable effect of HBOT for these patients and further studies are needed in order to defined the optimal sub-group of patient that will benefit the most.

SAFETY AND EFFICACY ASSESSMENT OF CONVENTIONAL LOW- AND HIGH-FREQUENCY REPETITIVE TRANSCRANIAL MAGNETIC STIMULATION FOR THE TREATMENT OF CHRONIC TINNITUS: DOSIMETRIC APPROACH

Perrot X.[1,2,3,4,5], Simon E.[1,2,3,4,6], Roche L.[2,7], Fornoni L.[1,3,4], Richard S.[2,5], Dubreuil C.[1,2,4,8], Truy E.[1,2,3,4,9], Norena A.[10], Boissel J.P.[1,2,4,11], Roy P.[1,2,4,7], Collet L.[1,2,3,4,5], and on behalf of the MagTIN study group
[1]Université de Lyon, France; [2]Hospices Civils de Lyon, France; [3]INSERM U1028, CNRS UMR5292, Lyon Neuroscience Research Center, France; [4]Claude Bernard - Lyon 1 University, France; [5]Lyon-Sud Hospital, Audiology and Orofacial Explorations Dept., Pierre-Benite, France; [6]Neurological and Neurosurgical Hospital, Functional Neurosurgery Dept., Bron, France; [7]Lyon-Sud Hospital, Biostatistics Dept., Pierre-Benite, France; [8]Lyon-Sud Hospital, ENT Dept., Pierre-Benite, France; [9]Edouard Herriot Hospital, ENT Dept., Lyon, France; [10]Université de Provence, Marseille, France; [11]Faculty of Medicine, Clinical Pharmacology Dept., Lyon, France

Background and Objective: Repetitive transcranial magnetic stimulation (rTMS) is regarded as a potential treatment modality for chronic tinnitus. Although previous studies demonstrated a slight therapeutic effect, optimal rTMS parameters and tolerability of multisession protocols remain to be specified. By combining various protocols, the objective of our study was to assess and characterize the effectiveness of conventional rTMS in patients with chronic severe tinnitus, while controlling safety and tolerability.

Materials and Methods: A randomized, double-blind, sham-controlled procedure, with four increasing levels of magnetic "pseudo-dose" was designed. Each level comprised 16 patients randomly assigned to active rTMS group (12 patients) or sham rTMS group (4 patients). The neuronavigated rTMS was centered over the primary auditory cortex contralateral to the perceived predominant

side of tinnitus. Effectiveness on tinnitus loudness, severity and handicap was assessed through visual analog rating scale, multidimensional self-questionnaires and tinnitometry. Safety and tolerance for rTMS sessions were evaluated through a semi-structured interview for adverse events and tonal audiometry for hearing status. The follow-up was spread over six months.

Results: Using a mixed-effects model for comparison to baseline measures, we showed that sham rTMS was more effective on tinnitus perception than active rTMS, regardless of the protocol. This paradoxical effect could be related to the higher incidence of specific magnetic stimulation related side effects (headache, facial contractions and pain) in groups with active rTMS.

Conclusions: Our findings question the therapeutic benefit of rTMS in tinnitus. Major multicenter clinical trials remain to be done. The simultaneous exploration of the various rTMS parameters, as well as taking into account the potentially negative side effects of rTMS, could enhance the methodological validity of these studies and help identify the optimal therapeutic protocol.

10:45 a.m. - 12:45 p.m.

SESSION 6:
Auditory & Cognitive Changes
Chair: Larry Roberts

Room: Erasmus

CORRELATION BETWEEN THE PSYCHOACOUSTIC MEASUREMENT, QUESTIONNAIRES AND PATIENT GLOBAL IMPRESSION OF CHANGE IN PATIENTS WITH ACUTE TINNITUS

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Background: There are four different approaches to investigate the evolution of tinnitus over a period of time: psychoacoustic tests, rating scales, questionnaires and patient global perception. However, these tests are time-consuming.

Purpose: The purpose of this study is to reveal possible correlations between the tests previously mentioned. So does improvement on the questionnaire scores reflect also in better results in the psychoacoustic measurements?

Method and patients: 35 patients participated to the audiological testing. These patients have a permanent, stable, non-pulsatile tinnitus caused by acute noise trauma or otitis media less than 3 months ago. The test protocol consists of the measurement of the minimal masking level (MML), loudness matches at 1 kHz, short version of the Tinnitus Handicap Inventory (TBF-12), Tinnitus Questionnaire (TQ), Numeric Rating Scale (NRS) of loudness and annoyance of the tinnitus and at least patient global perception of treatment-related change. The testing took place on the day of admission and after 90 days.

Results: No correlation between MML and the questionnaires was noted. However loudness matching correlates with TBF-12 and NRS, but these correlations are weak (ρ = 0,300).

Conclusion: An improvement of tinnitus measured with questionnaires does not reflect in an improvement on the psychoacoustic measurements. So we can decide that the psychoacoustic measurements do not contribute to a reliable evaluation of tinnitus.

Acknowledge: We thank the Stavros Niarchos Foundation and Auris Medical for the financial support for tinnitus research.

NEURAL PLASTICITY IN CENTRAL AUDITORY STRUCTURES IS EXPRESSED DIFFERENTLY IN TINNITUS

Roberts L.E., Thompson D.C, and Bosnyak D.J.
McMaster University, Hamilton, Canada

Sound therapies assume that auditory training alters the response properties of neurons in auditory pathways notwithstanding the presence of tinnitus. We investigated whether brain changes induced by auditory training in tinnitus sufferers and measured by EEG are similar to those induced in age and hearing level matched individuals without tinnitus. Auditory training was given using a 5 kHz 40-Hz AM sound that was in the tinnitus frequency region of the tinnitus subjects. The amplitude of the transient P2 response localizing to A2 increased with training equally in participants with and without tinnitus suggesting normal remodeling of this region in tinnitus. However, while the phase of the 40-Hz steady-state response (ASSR, localizing to A1) advanced toward the stimulus waveform by ten degrees during training in controls ($p = 0.006$), ASSR phase did not change significantly in the tinnitus group, although some participants showed phase shifts resembling controls. Normative phase shifts were more prominent in tinnitus when the dominant frequency of the tinnitus sound was disparate from the 5.0 kHz training stimulus, suggesting an interaction between synchronous neural activity related to tinnitus and stimulus-driven network behaviour in A1. On the other hand, ASSR amplitude increased with training in the tinnitus group, whereas in controls this response (which is difficult to remodel in normal hearing subjects) did not change with training. These results suggest that neural changes related to tinnitus alter how neural plasticity is expressed in A1. Implications for sound therapies and models of tinnitus are discussed. (TRI and NSERC of Canada)

CENTRAL GAIN: BEHAVIOURAL AND BIOLOGICAL RESPONSES IN TWO STRAINS OF MICE

Meltser, I.[1], Ek, B.[1], Hébert, S.[2], & Canlon, B.[1]

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[2] *École d'orthophonie et d'audiologie, Faculty of Medicine, Université de Montréal, Montréal, Canada ; BRAMS, International Laboratory for Research on Brain, Music, and Sound, Montréal, Canada*

Background: Decreased sensory input can be compensated for by increased neural sensitivity. Similarly, tinnitus can be the result of maladaptive plastic changes that could affect central gain. This study investigated the combined influence of enriched acoustic environment (EAE, low-level sound stimulation) or deprivation (ear plug) and genetic susceptibility to stress on the acoustic startle response.

Materials and Methods: Two mouse strains, one stress-resilient (C57bl/6) and another stress-responsive (BALBc) were first tested for startle responses and then either sound stimulated or deprived for one week. After the post-treatment behavioural testing, the mRNA and protein

expression for inhibitory neurotransmitters was assayed from the inferior colliculus and cochlear nucleus.

Results: The results show interesting behavioural features between the two strains of mice. For the BALBc, pre-post differences between EAE and deprivation were significant for startle, gap detection and prepulse inhibition. In the BALBc mice the silent condition produced a strong reduction in responses for all trial types. In contrast, the post-pre differences for the C57bl/6 were not significant between EAE and deprivation for any of the trial types. Using qPCR, an 18-fold change in mRNA for GABRA6 (GABA receptor subunit alpha-6) in the BALBc mice was found in the inferior colliculus when comparing EAE and deprivation. Protein expression for GABRA6 showed a similar change between the two conditions when western blotting and immunocytochemistry was performed in the BALBc. C57bl/6 mice did not show any such change.

Conclusions: These results demonstrate strain-specific behavioural and molecular profiles in the susceptibility to contrasting acoustic environments.

SALICYLATE INDUCES HYPERACTIVITY AND TONOTOPIC SHIFT IN AMYGDALA AND AUDITORY CORTEX

Salvi, R., Chen, G.-D., Manohar, S.,
University at Buffalo, Center for Hearing and Deafness, Buffalo, NY

The amygdala is believed to play an important role in tinnitus and hyperacusis. We evaluated the physiological changes in the lateral amygdala (LA) and auditory cortex (AC) before and after treating rats with a dose of salicylate that induces tinnitus and hyperacusis-like behavior. Systemic salicylate significantly increased local field potential (LFP) amplitudes making the LA hyperactive to sounds. Frequency receptive fields (FRF) of LA multiunit (MU) clusters were significantly altered by salicylate. Neuronal activity below 10 kHz and above 20 kHz was depressed at low intensities, but greatly enhanced between 10 and 20 kHz, frequencies associated with the tinnitus pitch. These frequency-dependent changes caused the FRF of many LA neurons to migrate towards 10-20 kHz thereby amplifying the activity from this region. To determine how salicylate-induced changes in the LA affected neural activity in the AC, we infuse salicylate (20 µl, 2.8 mM) into the amygdala. Local delivery of salicylate to the amygdala significantly increased the amplitude of the LFP recorded in the AC and selectively enhanced the neuronal activity of AC neurons in the 10-20 kHz. These results indicate that systemic salicylate treatment leads to hyperactivity and tonotopic shift in the amygdala and local infusion of salicylate into the amygdala can profoundly enhance sound-evoked activity in AC, changes likely to increase the perception and emotional salience of tinnitus and loud sounds.

MOLECULAR BASIS OF TINNITUS

Rüttiger L., Singer W., Zuccotti A., Panford-Walsh R., Matsumoto M., Zimmermann U., Jaumann M., Franz C., Geisler H.-S., Köpschall I., Rohbock K., Xiong H., Varakina K., Lee S.C., Verpoorten S., Schimmang T.[2], Knipper M.
[1] *University of Tübingen, Hearing Research Centre Tübingen, Molecular Physiology of Hearing, Tübingen, Germany;*
[2] *Universidad de Valladolid y Consejo Superior de Investigaciones Cientificas, Instituto de Biología y Genética Molecular, Valladolid, Spain*

Tinnitus is a non-curable stress-related brain disorder, that is mostly noise-induced and whose origin is unknown. We have addressed the molecular and physiological basis of this disease using a combined approach that included behaviorally tested tinnitus (Rüttiger et al., Knipper, Hear Res 2003), hearing measurements (including DPOAEs, ABRs and ABR wave analysis) and markers that trace network activity (Arc/Arg3.1). Data analysed the first time equally hearing impaired animals that were behaviorally distinguished in hearing impaired animals with and without tinnitus. We compared animals between the periphery of the cochlea and the auditory cortex, including the hippocampus and amygdala. We also included an analysis of altered responsiveness after stress priming. We unraveled a tinnitus specific trait that may explain some of the existing controversies about the molecular basis of tinnitus.

Acknowledgements. This work was supported by the Marie Curie Research Training Network CavNET MRTN-CT-2006-035367, the Deutsche Forschungsgemeinschaft DFG-Kni-316-4-1 and Hahn Stiftung (Index AG).

TINNITUS AND INSOMNIA: IS HYPERAROUSAL THE COMMON DENOMINATOR?

Wallhäusser-Franke E., Delb W.
Medical Faculty Mannheim, Heidelberg University, Phoniatrics and Audiology, Mannheim, Germany

Background: Sleep disturbances are frequent in the tinnitus population and tend to worsen tinnitus-related distress which in turn worsens sleep quality. Also, therapies that alleviate tinnitus-related distress have a positive influence on sleep quality. Clinical evidence suggests a potentially causal interaction between sleep and affective brain function as many mood disorders display co-occurring sleep abnormalities. Besides a high comorbidity with sleep problems, distressing tinnitus is often associated with mood problems. Hyperarousal caused by hyper-activation of the sympathetic nervous system was suggested as possible mechanism for insomnia, and animal models of insomnia and tinnitus indicated shared characteristics such as increased activation of the autonomous nervous system.

Materials and Methods: In a questionnaire-based cross-sectional survey we analyzed the data of 4705 individuals with tinnitus. The screening questionnaire contained psychometrically validated questionnaires addressing tinnitus-related distress, depressivity, anxiety, somatic symptom severity, a numeric rating scale for subjective tinnitus loudness, and questions about sleep problems.

Results: Almost 78% of the responders reported sleep problems. Severely distressing tinnitus was accompanied by sleep problems in 94.8%, but only in 60.4% of those with loud tinnitus. Moreover, in the group with low tinnitus-related distress only 8.2% were 'feeling nervous, anxious or on the edge' compared to 57.8% in the group with high tinnitus-related distress, whereas this ratio was 12% to 34.2% for low and high subjective tinnitus loudness, respectively.

Conclusions: Findings are in line with the assumption that distressing tinnitus and insomnia may both be promoted by hyperarousal due to hyperactivity of the sympathetic nervous system.

1:45 - 4:15 p.m.
PLENARY TALKS

1:45 - 2:30 p.m. – Keynote Speaker
THE NEURAL CORRELATES OF CONSCIOUS PERCEPTS

Steven Laureys
Steven Laureys leads the Coma Science Group at the Cyclotron Research Center and Department of Neurology, Sart Tilman Liège University Hospital. Steven is Clinical Professor (ULg) and Senior Research Associate (tenure) at the Belgian National Fund of Scientific Research (FNRS). He is board-certified in neurology (1998) and in palliative and end-of-life medicine (2004) and presently is invited professor at the Collège Belgique (Belgian Royal Academy of Sciences) and chair of the "European Neurological Society Subcommittee on Coma and disorders of consciousness". A recipient of the William James Prize (2004) from the Association for the Scientific Study of Consciousness (ASSC) and the Cognitive Neuroscience Society (CNS) Young Investigator Award (2007), he published several books: The Neurology of Consciousness (with Giulio Tononi, Academic Press, 2008); Coma Science (with Adrian Owen et Nicholas Schiff; Elsevier 2009); Disorders of Consciousness (with Nicholas Schiff, Wiley, 2009) and The Boundaries of Consciousness (Elsevier, 2005). His contribution at the TRI meeting on auditory awareness and consciousness will hugely benefit all those interested in understanding tinnitus as a problem of too much auditory awareness.

You are your brain. Neurology is the study of mankind itself. We will here briefly review some neurological facts on consciousness and impaired consciousness. While philosophers have pondered upon the mind-brain conundrum for millennia, scientists have only recently been able to explore the connection analytically through measurements and perturbations of the brain's activity. This ability stems from recent advances in technology and especially from emerging functional neuroimaging and electrophysiology studies. The mapping of conscious perception and cognition in health (e.g., conscious waking, sleep, dreaming, sleepwalking and anesthesia) and in disease (e.g., coma, near-death, "vegetative" state, seizures, hallucinations etc) is providing exiting new insights into the functional neuroanatomy of human consciousness and, as we will here see, of tinnitus.

Philosophers might argue that the subjective aspect of the mind will never be sufficiently accounted for by the objective methods of reductionistic science. We here prefer a more pragmatic approach and remain optimistic that technological advances will ultimately lead to an understanding of the neural substrate of consciousness. Furthermore, these scientific advances offer the medical community unique ways to improve our understanding and clinical management of disorders of consciousness and conscious perception.

2:30 - 3:15 p.m. – Keynote Discussion
ART VS SCIENCE

JAN FABRE, György Buzsáki
Jan Fabre *is a world famous Belgian multidisciplinary artist, playwright, stage director, choreographer and designer. He studied at the Municipal Institute of Decorative Arts and the Royal Academy of Fine Arts in Antwerp. Established in 1986, Troubleyn/Jan Fabre is a theatre company with extensive international operations, with its home base in Antwerp, Belgium. In 1990, he covered an entire building with ballpoint drawings. He also makes sculptures in bronze (among them 'The man who measures the clouds' and 'Searching for Utopia') and with beetles. His decoration of the ceiling of the Royal Palace in Brussels Heaven of Delight (made out of one million six hundred thousand jewel-scarab wing cases) is widely praised. Jan Fabre's The Angel of Metamorphosis exhibition was held at the Louvre Museum and in 2011. His Pieta, which caused a lot of controversy, was organized to coincide with the 54th edition of the Venice Biennale*

György Buzsáki *is a Board of Governors Professor of Neuroscience at Rutgers University. His primary interests are brain oscillations, sleep and memory. With more than 200 papers published on these topics, he is among the top 250 most-cited neuroscientists. Dr. Buzsáki is a Fellow of the American Association for the Advancement of Science, an honorary member of the Hungarian Academy of Sciences and author of the popular book "Rhythms of the Brain". In 2011 he won the 'Brain Prize', awarded to one or more scientists who have distinguished themselves by an outstanding contribution to European neuroscience. In view of the recently suggested involvement of the hippocampus in tinnitus, his contribution on hippocampal function will enlighten tinnitus researchers. Innovation in science will meet innovation in art when György Buzsáki debates with Belgian innovative artist of international stature Jan Fabre.*

3:45 - 4:15 p.m. – Invited Speaker
IS THE UNIVERSITY THE RIGHT PLACE FOR INNOVATION? A HISTORICAL APPROACH

Hilde De Ridder-Symoens
Hilde De Ridder-Symoens is an internationally acclaimed historian, having investigated the history of European universities for more than 40 years. She has been a long term visiting fellow and/or professor at the Max-Planck Institute in Frankfurt/Main (1983), University of Berkeley (1993 and 1998) and Merton College, Oxford (1994), and has widely lectured in Europe at the universities of Leuven, several Dutch universities, Helsinki, Tampere, Reykjavik (Socrates), Bern, Eichstätt, Prague, Oxford, Edinburgh, Dublin, as well as in the USA (1991: Brown, Holy Cross, Worcester Polytechnic Institute, Columbia University, Georgetown) and in Canada (1993: Vancouver, Calgary, Montreal, Halifax). She won the Sarton Medal for her work on the History of Science. Her talk on innovation is science and the love-hate relationship between universities and innovation will be very rewarding.

The history of the university shows how and why the university grew to encompass the whole of knowledge in most of the world, how it developed an intellectual tradition common to all Europeans, and how it trained academic and professional elites whose ethos transcends national boundaries. It also shows the ambiguous relationship towards science in general and invention and innovation in particular. Since the nineteenth century, we are used to associate universities with basic and applied research, and, as a consequence, with invention and innovation. In my paper, I will demonstrate that the relation between university and research in the Middle Ages and the Early Modern Times (i.e. before 1800) is not so obvious and that you could formulate it more as a love-hate relationship. In the discussion, it is essential to consider the content of invention and innovation and its changes in meaning in the course of time. Since the 1960s the governments – and in their wake the academic authorities - attribute a more and more technical and economical meaning to invention. Universities are considered as generators and developers of such innovations. Pragmatism is dominating the university discourse resulting in a pronounced reduction of theoretical, fundamental and not straight applicable research. This raises the question what the mission of the university is, and in how far the current discourse is space and time bound. Has politics an impact on the characteristics of invention and on the resulting innovations? What does the history of the university tells us about the interaction. In my paper, I will try to give an answer to all these questions.

4:15 p.m.- 5:30 p.m.

SESSION 7: Treatment
Chair: Richard Tyler

Room: Morus

MECHANICALLY INDUCED TINNITUS OBSERVED IN COCHLEAR IMPLANT USERS WITH RESIDUAL HEARING

Baumann, U., Helbig, S., Stöver, T.
Audiological Acoustics/ENT-Department, Goethe-University Frankfurt, Germany

Background: Patients suffering from a partial deafness in higher frequencies are candidates for electric-acoustic-stimulation (EAS). Highly developed surgical techniques as well as very thin electrode arrays facilitate the preservation of acoustic hearing to a large extent. A potential problem might result in areas where the basilar membrane is in close contact to the electrode and mechanical movement of the array is possible.

Patients: Patient 1, male, aged 48y, acquired functional deafness in the left ear after several ear surgeries attempting to reconstruct the ossicular chain. Profound conduction with combined sensorineural hearing loss was present in the higher frequencies, whereas PTA thresholds were normal at and below 1 kHz prior to CI surgery. After CI surgery, bone conduction thresholds were best 25 dB HL at 125 Hz. CT and Stenvers radiograph imaging showed normal electrode insertion. The patient complaints about severely tinnitus induced by movements of the external ear or by touching the skin surface above the stimulator body. Patient 2, female, aged 59, with a history of progressive hearing loss and a questionable auditory synaptopathy received her first implant in the right ear 2009. The second ear was implanted 01/2012 and showed preserved hearing after implantation with best threshold at 3 kHz with 65 dB HL. As seen in patient 1, she also complained about tinnitus generated by movements of the outer ear or at the stimulator.

Conclusion: Mechanically induced tinnitus should be considered as a possible complication in cochlear implant recipients with highly preserved residual hearing. As a consequence, a sufficient fixation of the electrode array should be considered as prevention.

NEUROETHICAL ISSUES IN TINNITUS RESEARCH AND CARE

Erik Viirre
University of California, San Diego , Neurosciences

Ongoing development of diagnostic tests and treatments for tinnitus, and limited resources available to evaluate and treat this condition generates a number of ethical issues. For example, diagnosis and care of tinnitus raises issues about the benefits, burdens (e.g.-invasiveness), and risks of extant treatments, the distribution of societal resources to those with a complaint of tinnitus, and the development of tests that may be objective markers of this condition. If an "objective" test for tinnitus were to be developed, how should it be utilized and how will false positives and false negatives potentially be managed – given that many patients seek fiscal compensation of this condition? How do we design ethically sound studies and treatments for invasive, potentially toxic and/or addictive treatments? Tens of millions of people have "low level" tinnitus: what metrics and level of resource allocation should be developed to address their condition? Finally, it has been suggested that tinnitus, especially the more severe forms of the condition can be life-threatening, in that psycho-social effects can degrade patients' lives and prompt suicide. Thus, any attempt at objectification must consider the subjective manifestation of the condition, its diagnosis, and resulting trajectories of care. We believe that many of these issues and contingencies are aligned with the questions and discourse of neuroethics, and thus, this paper posits a neuroethical approach to address and articulate a framework for the problems arising in research and clinical intervention.

MULTIDISCIPLINARY ASSESSMENT AND TREATMENT OF TINNITUS: A FOLLOW UP STUDY

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[1] *Department of Otorhinolaryngology and Head and Neck surgery, University Medical Center Groningen, Groningen, the Netherlands*
[2] *Department of Health Sciences, University Medical Center Groningen, Groningen, the Netherlands*

Background: A multidisciplinary outpatient clinic was started in the University Medical Center in Groningen in August 2007 to help patients to enhance their tinnitus management. A recent follow up assessment was done to study whether changes had taken place in the impact of tinnitus on patients' functioning and Quality of Life after they visited the outpatient clinic.

Materials and Methods: In this observational prospective study, 260 consecutive patients were asked to participate in a follow up assessment by means of self-report questionnaires (THI, HADS and RAND-36). Time between T1 and T2 was 6 months to 2 years. In total, 174 patients (aged 58 ± 11; 68% male) were included (response rate of 67%).

Results: For the total group of patients, no significant changes were found between T1 and T2 in tinnitus handicap, anxiety, depression and quality of life domains psychological functioning and general health perceptions. Comparing subgroups, significant improvements were found in THI-scores in the group of patients with both hearing aids and counselling (mean difference = 11.7, SD = 17.3, $p < .05$). In the counselling group a significant reduction in anxiety-scores was found (mean difference = 3.1, SD = 4.3, $p < .05$). In patients with hearing aids alone, no significant changes in THI and HADS scores were found.

Conclusions: Significant improvements in tinnitus handicap were found for patients with hearing aids and counselling. Furthermore, the counselling group showed an improvement in anxiety. Although small groups were studied, positive results were found for hearing rehabilitation and counselling.

TINNITUS SUPPRESSION WITH MIXED BACKGROUND STIMULI IN A WEARABLE COCHLEAR IMPLANT

Richard Tyler[1], Kurt Walker[1], Shelley Witt[1], Matthijs Killian[2], Norbert Dillier[3], Pim van Dijk[4] and Wai Kong Lai[3]
[1] *The University of Iowa*
[2] *Cochlear Technology Center, Mechelen, Belgium*
[3] *Department of Otorhinolaryngology, University Hospital, Zürich, Switzerland.*
[4] *Department of Otorhinolaryngology/Head and Neck Surgery, University Medical Center, Groningen, Netherlands.*

We mixed background sounds provided by a wearable sound playback device with the electrical signal provided by a cochlear implant speech processor in an attempt to suppress tinnitus. First, laboratory trials were used to select effective and different background stimuli. Four stimuli were

then programmed into the playback device memory. Second, in a field trial subjects used one background stimulus each day, and alternated among the four during 28 days. Each evening the patients went online to rate the loudness, annoyance, and acceptability (0-100%). The patient completed the Tinnitus Handicap Questionnaire and the Tinnitus Activities Questionnaire 12-item version. Results indicated that some background sounds were very effective and acceptable. The most acceptable sounds varied across individuals.

We wish to thank Action on Hearing Loss, the Tinnitus Research Initiative, and Cochlear Corporation for their generous support.

SUSTAINED SUPPRESSION OF SEVERE TINNITUS WITH MED-EL COCHLEAR IMPLANTS IN SINGLE-SIDED DEAFNESS: 8 YEARS EXPERIENCE

Kleine Punte, A.[1], Hofkens, A.[1], Mertens, G.[1], De Bodt M[1]., Van de Heyning, P[1].
[1] *Univ. Dept. Otorhinolaryngology and Head and Neck Surgery, University Hospital Antwerp, University of Antwerp, Antwerp, Belgium*

Background: Cochlear implantation (CI) may offer long-term tinnitus suppression in patients with severe sensorineural hearing loss by providing input to the auditory nervous system. An indication for the use of CI's is in individuals with single-sided deafness (SSD) and incapacitating tinnitus in that ear. This prospective clinical trial investigates the long-term effects of this treatment.

Material and Methods: 30 subjects suffering from severe tinnitus of more than 6/10 on a Visual Analogue Scale (VAS) due to SSD were included. CI was performed with a MED-EL CI, with the electrode array fully inserted into the scala tympani. Nineteen of these subjects had contralateral normal hearing, and eleven used a hearing aid contralaterally. Tinnitus assessment consisted of a tinnitus loudness estimation by means of the VAS and psychoacoustical measurement. The Tinnitus Questionnaire (TQ) was also administered pre-implantation and yearly up to 8 years post-implantation (n=10).

Results: All patients reported a subjective benefit after implantation. A reduction of tinnitus loudness was obtained in 28/30 subjects. The VAS score reduced significantly from 8.9/10 to 2.6/10. Also the TQ total score decreased significantly, the mean tinnitus degree decreased from severe to mild. The tinnitus suppression obtained remained stable up to 8 years after cochlear implantation.

Conclusion: Incapacitating tinnitus accompanied by severe to profound sensorineural hearing loss can successfully be treated by CI. 8 years of experience with this treatment at the ENT department of the Antwerp University Hospital proves that CI is an efficient and safe procedure in the management of tinnitus in this particular patient

4:15 p.m. - 5:30 p.m.
SESSION 8: Pathophysiology
Chair: Grant Searchfield
Room: Erasmus

KINESIA TAPING FOR TINNITUS

Marja Estola
Honkaharju hospital, Otolaryngology

Kinesia taping is a method, to treat muscles and swelling of extremities. It has become popular in sports to correct and balance muscular movements and in physiotherapy to treat stiff muscles and pain.

I have treated tinnitus by lidocain injections to trigger points and cold streching. Now I have tried kinesia taping to continue the effects of former treatment with easier way. So far I have tried it for just 10 patients. But it seems to work with some of them. I have to try the tapes on different muscles and different directions to find the optimal way. But the method is easy, cheap and the patients can probably do it themselves in the future.

I would like to discuss about the method with other scientists, who treat tinnitus by muscular streching or massage

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GAME TRAINING OF TINNITUS

Searchfield G.D., Wise K., Kobayashi K.
Section of Audiology, School of Population Health, and the Centre for Brain Research, The University of Auckland, Auckland, New Zealand

Introduction: It is believed that the majority of tinnitus results from peripherally injury-induced plasticity of the central auditory pathways along with co-activation of attention and memory networks. It has been hypothesized that such maladaptive plasticity might be reversed or altered through perceptual training. The basis of perceptual training is that by exposure to sensory stimuli we learn, improving such perceptual skills as discrimination and attention, potentially reducing tinnitus.

Aim: This presentation will introduce several game based perceptual training tasks before describing subjective and objective outcomes of a trial comparing an attention based auditory training game ("Terrain") to a visual task ("Tetris"). The benefits, limitations and potential mechanisms underpinning the training will be discussed along with implications for clinical practice and research.

Methods: Two groups of 16 persons each completed pre-baseline, baseline, post-treatment and washout measures of tinnitus (including Psychoacoustic matching, Quality of Life measures (Tinnitus Functional Index, Rating scales), behavioural measures of attention, and Cortical Auditory Evoked Potentials).

Results: Short-term training using computer based games showed benefit for tinnitus management across a number of measures within a short timeframe. Treatment success may not arise solely from auditory training, with attention related processing believed to be a significant contributor to the benefits seen.

Conclusions: Game-based perceptual training of tinnitus offers new opportunities for treatment and research.

WHEN AND WHY USING VERTEBRAL MANEUVERS AS A TINNITUS TREATMENT.

Wiener V.*, Haenecour L.**
* *ENT Department, Clinique du Parc Léopold, Brussels, Belgium*
** *Service de Médecine Physique et de Réadaptation, Cliniques Universitaires Saint-Luc, Université Catholique de Louvain, Brussels, Belgium.*

Background: Some tinnitus patients complain about changes in the noise they perceive when moving they head. The perceived noise could be more or less intense. We wanted to explore the cervical spine of those patients.

Materials and Methods: We did a prospective study on patients whose tinnitus was modified by a change in the position of the neck and on tinnitus patients without hearing loss. We did complete oto-neurological examinations, we performed audiogram with acoumetry and otoemissions when tinnitus was between 1 and 4 kHZ. The patients were referred to the Department of Physical Medicine where a attentive examination of the cervical spine was possibly completed with a cervical Xray or Scanner and sometimes with a MRI. A manual cervical treatment or lordosis exercises were completed.

Results: We included 40 patients, 26 women and 14 men, average age of 42 ranging from 19 to 75. They had pulsatile (1) or non-pulsatile (39) tinnitus, some of them had a previous history of whiplash (14), arthrosis, hernia or cervical surgery. Two of them had hyperacousis. Physical examination of the neck was normal in 4 cases. Out of those 40 patients, 34 benefited from a vertebral manipulation, 2 were excluded because of a contraindication and 4 showed no cervical abnormalities.

Conclusions: Vertebral maneuvers have a positive impact on patients with tinnitus and cervicalgia and abnormalities on the upper cervical spine. In our experiment after less then 3 sessions we got good results in relation to their tinnitus.

TINNITUS IN PATIENTS WITH SINGLE SIDED DEAFNESS PRIOR TO AND AFTER A BONE CONDUCTION DEVICE TRIAL

Jolien Desmet, Marc De Bodt and Paul Van de Heyning
Univ. Dept. Otorhinolaryngology, Head and Neck Surgery, Antwerp University Hospital, Belgium
Faculty of Medicine, Campus Drie Eiken, University of Antwerp, Belgium

Background: The presence of tinnitus is often mentioned as an additional burden in difficult listening conditions by patients with unilateral sensorineural hearing loss (SSD). We know from previous studies that the use of a cochlear implant in the deaf ear might significantly reduce tinnitus (1). A bone conduction device (BCD) has also been used as a treatment in this patient group that often suffers from tinnitus. The BCD is used as a CROS system. Sound is picked up by the device on the deaf side and transmitted to and processed by the normal working cochlea and auditory nerve on the better hearing side. Data on tinnitus reduction with this treatment option are however not available.

Purpose: We aim to provide data on tinnitus loudness and distress in patients with single sided deafness and on the effect of a BCD trial and BCD implantation on the perceived tinnitus.

Material and methods: SSD patients were asked to complete the tinnitus questionnaire (TQ) and to indicate tinnitus loudness on a Visual Analogue Scale (VAS) prior to and following a BCD trial. Experienced SSD BCD users were asked to complete the TQ, to indicate tinnitus loudness on a VAS and to also report the effect of their BCD on tinnitus loudness and distress.

Results: Results and conclusions will be presented at the TRI conference in June.

Reference List

1. Van de Heyning P, Vermeire K, Diebl M et al. Incapacitating unilateral tinnitus in single-sided deafness treated by cochlear implantation. Ann Otol Rhinol Laryngol 2008;117:645-652.

COUNTERACTING TINNITUS SYMPTOMS AND RELATED CEREBRAL SYNCHRONY BY ACOUSTIC CR NEUROMODULATION

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[2] *Department of Stereotactic and Functional Neurosurgery, University of Cologne, Cologne, Germany.*

Introduction: Subjective tinnitus is associated with pathologic enhanced neuronal synchronization.

Aim: We used a model based desynchronization technique, acoustic coordinated reset (CR) neuromodulation, to specifically counteract tinnitus-related neuronal synchrony thereby inducing an unlearning of pathological synaptic connectivity and neuronal synchrony.

Patients and Methods: In a prospective, randomized, single blind, placebo-controlled trial in 63 patients with chronic tonal tinnitus and up to 50 dB hearing loss we studied safety and efficacy of different doses of acoustic CR neuromodulation1. We measured visual analogue scale, tinnitus questionnaire (TQ) scores and spontaneous EEG.

Results: CR treatment was safe, well-tolerated and caused a significant decrease of tinnitus loudness and symptoms. Effects gained in 12 weeks of treatment persisted through a preplanned 4-week therapy pause and showed sustained long-term effects after 10 months of therapy: Response, i.e. a reduction of at least 6 TQ points, was obtained in 75% of patients with a mean TQ reduction of 50% among responders. CR therapy significantly lowered tinnitus frequency and reversed the tinnitus related EEG alterations in a network comprising auditory and non-auditory brain areas (CR-induced decrease of delta and gamma together with an increase of alpha), both indicative of CR-induced neuroplastic changes.

Conclusions: Acoustic CR neuromodulation causes both a significant clinical improvement and a significant decrease of pathological neuronal synchronization.

1 Tass P.A. et al. Rest. Neurol. Neurosci. 30 (2012)

SATURDAY
JUNE 16, 2012

9:00 - 10:15 a.m.
PLENARY TALKS

9:00 - 9:45 a.m. – Keynote Speaker
COMPUTATIONAL MODELS OF TINNITUS: THEORY, EXPERIMENTAL TESTS, AND IMPLICATIONS FOR TREATMENT

Roland Schaette
Roland Schaette started doing research on tinnitus in 2003, and since November 2008 working in London at the UCL Ear Institute as the British Tinnitus Association Senior Research Associate. His main interest is the auditory system and neuronal plasticity. His research questions focus on 'Can tinnitus be linked to a specific type or pattern of cochlear damage?', 'How can cochlear damage lead to the development of tinnitus-related neural activity patterns in the auditory system?', 'How does the auditory system react and adapt to altered input, for example after hearing loss through damage to the cochlea? And which mechanisms of activity dependent neuronal plasticity are involved?' and 'How can plastic changes after hearing loss be reverted through acoustic or electric stimulation?'. These questions are addressed using theoretical models, animal studies, and studies with human subjects. As an upcoming scientific leader in the tinnitus field his ideas on the mechanisms that underlie tinnitus will be stimulating and foster more research in the future.

The understanding of tinnitus has progressed considerably through animal models and human neuroimaging studies. It is now clear that tinnitus is generated through pathologically altered spontaneous activity of neurons in the central auditory system. However, the details of the mechanisms that give rise to these aberrant neuronal activity patterns have not yet been pinpointed. In my talk, I will illustrate how computational modeling has been used to explore which mechanisms could give rise to putative neuronal correlates of tinnitus, showing that a model based on the principle of activity stabilization through homeostatic plasticity can account for the development of neuronal hyperactivity as observed in animal studies. Moreover, when applied to the audiograms of patients with noise-induced hearing loss and tonal tinnitus, the model predicts tinnitus frequencies close to the observed tinnitus pitch. The model thus proposes a specific mechanism for how plasticity in the central auditory system could lead to the development of tinnitus after cochlear damage. The homeostasis model can also account for recent experimental findings from tinnitus patients with normal audiograms, and it can explain why auditory deprivation through an earplug can lead to the occurrence of phantom sounds. As an outlook, I will discuss how computational models can help to understand the effects of different tinnitus treatment strategies better, e.g. why hearing aids not always provide tinnitus relief, and why certain drugs fail to decrease tinnitus. In the future, computer models of tinnitus might inspire new experiments and contribute to new treatment approaches.

9:45 - 10:15 a.m. – Invited Speaker
THE FUTURE OF MEDICINE - A MARKETING PERSPECTIVE

Jens Gutsche
Jens Gutsche is Professor for Marketing and E-Commerce at the University of Applied Sciences Merseburg, Germany. After his studies in industrial engineering and a doctoral degree in business and administration he has held positions as marketing director at various companies such as EON, Lufthansa, Telecom and Vodafone. He has a special interest in the impact of electronic media and internet based communication on marketing and commerce. In his talk he will focus on the transformation of business, administration and society through mobile internet, big data and real-time availability of information. Finally he will discuss possible implications for the future development of clinical medicine and the health market.

University of Applied Sciences Merseburg, Germany & Mücke, Sturm & Company, Germany Mobile Internet, BIG DATA and real-time measures are the new hallmarks of marketing. They transform businesses, markets and society and might have impact to the future of medicine as well. Patients are better informed, have more power and to act with more self-responsibility than ever. e-Health solutions will offer connected diagnostics and desease management, e-consultation and e-care solutions, e-recepies, storage and data mining of patients information in the cloud and auditing of treatments via call center. International Telcos like Vodafone and France Telecom start to offer communication and IT-Services to support to shape the future of medicine. OECD estimates, that until 2020 the health care sector will rise up to 16 percent of BIP in Europe. One of the key questions: What can medicine learn about it`s own future from developments and transformations currently taking place in marketing across the world.

10:45 a.m. - 12:45 p.m.
SESSION 9: Functional Imaging
Chair: Tony Cacace
Room: Morus

NEUROFEEDBACK TREATMENT IN TINNITUS PATIENTS: A COMPARATIVE STUDY OF DIFFERENT TREATMENT STRATEGIES.

T. Dietzen, T. Balkenhol, W. Delb
Heidelberg University, Medical Faculty Mannheim, Dep. of Phoniatrics and Audiology, Mannheim, Germany

Background: It has been shown that alterations in oscillatory brain activity are associated with the emergence of tinnitus. Consequently a neurofeedback treatment aiming at modifying this pathological activity could be able to improve tinnitus related distress as well as tinnitus loudness.

Materials and Methods: 60 tinnitus patients (41 male, 19 female) with chronic tinnitus (>1 year) were enrolled in the study and allocated to different treatment strategies. Group 1 performed a neurofeedback treatment aiming at increasing alpha and decreasing delta oscillatory activity. In group 2 the training aimed at decreasing beta and increasing alpha activity and the patients in group 3 tried to reduce theta and increase alpha oscillatory activity. In group 4 the patients performed an attention training combined with

relaxation training. Treatments were performed in 16 sessions lasting 30 minutes each.

Results: In group 1 ("delta/alpha- training") tinnitus related distress as measured using the Goebel and Hiller tinnitus questionnaire improved significantly ($p<0.05$) which was not the case in groups 2, 3 and 4. In group 3 ("theta/alpha-training") the subscore "sleep disturbances" improved significantly whereas in group 2 a highly significant reduction of minimal masking level was observed after the therapy.

Conclusions: These data suggest that neurofeedback treatment of tinnitus represents a promising treatment option. Esp. the delta/alpha feedback is able to reliably reduce tinnitus related distress. However it seems that depending on the primary complaint of each patient also theta/alpha and beta/alpha- training can be successfully applied.

FIRE AND FORGET: COMPARISON OF THE EFFECTS OF NEUROMODULATION BY LOW-FREQUENCY RTMS AND NEUROFEEDBACK ON OSCILLATORY PROCESSES RELATED TO TINNITUS

Hartmann, T[1], Lorenz, I[1], Müller, N[1], Langguth, B[3] and Weisz, N[1,2,4]

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[3] *Universität Regensburg, Department of Psychiatry, Regensburg, Germany*
[4] *Università degli Studi di Trento, CIMeC, Center for Mind / Brain Sciences, Trento, Italy*

Background: Increasing evidence has arisen that chronic tinnitus is related to a disturbance in the auditory excitatory-inhibitory balance. Neurophysiological correlates of this imbalance are increased delta power and decreased alpha power. Because of its relation to inhibitory processes, alpha oscillations have a special role in this theory and are a candidate for representing changes after tinnitus therapy. Although promising results exist on the effectiveness of both Neurofeedback and rTMS, no evidence exists whether neurophysiological changes are induced by these methods and of what kind they are, as well as where in the cortex these changes are induced. The current study compares behavioral results and MEG recordings before and after Neurofeedback, verum rTMS or sham rTMS treatment.

Materials and Methods: We report data from 17 patients (8 Neurofeedback; 9 rTMS). Resting-state MEG was performed before the first and after the last treatment. We analyzed the power and the long-range connectivity on the source-level.

Results: The results show that Neurofeedback treatment is superior to rTMS and spatially specific. Alpha power increase, signifying increased inhibition at the right auditory cortex, is found after Neurofeedback only. Connectivity effects are more widespread through conditions.

Conclusions: The neurophysiological effects of Neurofeedback shown in this study are very specific to the areas trained. The question, whether rTMS provides a similar specific modulation cannot be answered here as no corresponding effect was found. However, it remains possible that rTMS induces cortical inhibition via mechanism different from Neurofeedback. In this case, rTMS effects could also manifest themselves differently.

NEURAL CORRELATES OF TINNITUS ANNOYANCE: RESULTS FROM AN EMOTIONAL STROOP TASK

D. Golm[1], C. Schmidt-Samoa, P. Dechent, B. Kröner-Herwig

1 University of Göttingen, Clinical Psychology and Psychotherapy

Background: Chronic tinnitus affects approximately 5% of the population. However, 20% of the tinnitus afflicted individuals are severely distressed by the tinnitus. It is commonly believed that the cognitive-emotional appraisal of the phantom noise and its assumed consequences is an important factor determining tinnitus annoyance. It has been proposed that highly distressed tinnitus patients differ from low distressed tinnitus patients in the activity of a fronto-parietal-cingulate network. The aim of our study was to identify neural correlates of tinnitus annoyance.

Method: A sample of 16 highly annoyed tinnitus patients and age and sex matched groups of low annoyed tinnitus patients (n=16) and healthy controls (n=16) underwent functional magnetic resonance imaging (fMRI) during an Emotional Stroop Task. After the MRI all stimuli were rated by means of arousal and valence. A subsample of the highly annoyed tinnitus patients received cognitive-behavioral training to reduce tinnitus-related distress. The responders and age and sex matched low distressed tinnitus patients underwent the Emotional Stroop Task a second time during fMRI.

Results: With regard to reaction times, there were no differences between tinnitus-related and neutral words within the groups, nor any differences between the three groups. However, within the group of highly annoyed tinnitus patients tinnitus-related words were evaluated as being more negative and arousing than neutral words. There were no differences between tinnitus-related and neutral words within any of the other groups. Final data will be presented.

INCREASED FRACTIONAL ANISOTROPY (FA) IS ASYMMETRIC AND LOCALIZED PRIMARILY TO WHITE MATTER TRACKS IN THE LEFT HEMISPHERE: A DIFFUSION TENSOR IMAGING STUDY OF NOISE-INDUCED TINNITUS

Benson R.R., Gattu R., Cacace A.T.

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[2] *Department of Radiology, Wayne State University School of Medicine, Detroit, USA;*
[3] *Department of Communication Sciences & Disorders, Wayne State University, Detroit, USA*

Background: Diffusion tensor imaging (DTI) is a contemporary neuroimaging modality used to study white matter tracts in the brain (connectivity and microstructure). We used DTI to better understand the neurobiology of noise-induced tinnitus most frequently associated with partial peripheral deafferentation (i.e., noise induced hearing loss, NIHL).

Materials and Methods: Two groups of adults with a history of occupational, recreational, or military noise exposure, with and without tinnitus, matched for degree of hearing loss and age were studied. Group 1 consisted of adults with NIHL without tinnitus (n =13, mean age 58 years, range 22-88 years); Group 2 consisted of adults with NIHL with tinnitus (n =13, mean age 54 years, range 28-80 years). Magnetic resonance imaging data were collected at the Center for MR Research, using a 3 Tesla Siemens MAGNETOM Verio scanner employing a 32-channel head coil with diffusion-sensitizing gradients applied in 20 non-collinear directions.

Results: While FA of global white matter did not differ significantly between groups; there were 9 regions which

showed significantly increased FA for the tinnitus-positive group. The majority (7/9) were left-sided, including five regions localized to left anterior thalamic radiations, one in the superior longitudinal fasciculus (SLF), and one in the inferior (ILF). Two right-sided regions were localized to the inferior fronto-occipital fasciculus and SLF; only a single region of the SLF in the left parietal lobe showed reduced FA.

Conclusions: Individuals with chronic noise-induced tinnitus showed aberrant white matter microstructure which was asymmetric and consistent with increased myelination, decreased axonal diameter, increased packing density, and/or decreased branching.

CHANGES ASSOCIATED WITH TINNITUS AND HEARING LOSS IN FUNCTIONAL BRAIN NETWORKS INVOLVED IN SHORT-TERM MEMORY AND ATTENTION

Fatima Husain
Department of Speech and Hearing Science, University of Illinois at Urbana-Champaign, Champaign, Illinois, United States of America.

Introduction: Tinnitus and hearing loss (HL) have been linked to reorganization of several functional neural networks, including those concerned with auditory and short-term memory processing. Limited understanding of such neural plasticity prevents development of effective treatments for tinnitus.

Aim: To test the hypothesis that tinnitus and HL sufferers use a different functional brain network for short-term memory.

Patients and Methods: Functional magnetic resonance imaging data were acquired from two subject groups: 11 persons with HL and tinnitus (TIN) and 7 normal hearing age- and gender-matched persons without tinnitus (NH). Data obtained while subjects performed auditory short-term memory tasks requiring low (LO) or high (HI) attention were preprocessed and analyzed with a general linear model. Stimuli were tones in the hearing range of all participants, 500-1000 Hz. In LO tasks, subjects determined whether two such tones were identical or not, and in HI tasks, whether the last tone was identical with any of the first two tones or not.

Results: Both groups took longer to complete the HI task relative to the LO task and exhibited greater brain response to the former task when compared to rest. NH showed more extensive activation relative to TIN for a HI>LO contrast at $p<0.001$ (uncorrected). Frontal activation was largest in medial and superior frontal gyri for NH and in inferior and middle frontal gyri for TIN, suggesting differential response of the attentional network.

Conclusion: Neural plasticity due to tinnitus alters short-term memory and attentional networks. Therapies targeting such networks should be evaluated.

FUNCTIONAL NEAR-INFRARED SPECTROSCOPY AS NEW AND INNOVATIVE NEUROIMAGING TOOL IN TINNITUS?

Schecklmann, M.,[1] Tupak, S.,[2] Zeller, J.,[2] Harnisch, W.,[3] Giani, A.,[4] Fallgatter, A.J.,[5] Langguth, B.[1]
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Background: In recent years, human neuroimaging enhanced the understanding of neural mechanisms of tinnitus. However, each neuroimaging technique has specific limitations. Here, we provide first preliminary data in tinnitus from functional near-infrared spectroscopy (fNIRS) - an optical, not magnetic approach to measure blood oxygenation level dependent signals. fNIRS is a valid and reliable method with limited spatial resolution, but was shown to be capable to measure activity in auditory cortex.

Materials and Methods: White noise was presented in an event-related (40 x 1.75s with 12-14s breaks) and block-wise (12 x 20s with 20s breaks) manner in 40 patients with tinnitus and 20 controls comparable for age and gender. The fNIRS probe-sets (2 x 22 channels) were placed over temporal areas.

Results: Preliminary analyses indicate that tinnitus was associated with reduced auditory cortical oxygenation in both designs in contrast to controls.

Conclusions: fNIRS is capable to add relevant information to sound evoked activity in auditory cortex. Future studies might be able to add more precise knowledge of auditory cortex activity with respect to the laterality and the character of the tinnitus percept. fNIRS might also be valuable in measuring brain areas which are challenging measureable by functional magnetic resonance imaging, i.e., orbital-frontal cortex due to susceptibility artefacts.In addition, further research should concentrate on resting state measurements or on combined fNIRS-EEG measurements obliterating the limitations of both techniques.

LACK OF TONOTOPIC CORTICAL REORGANIZATION IN TINNITUS

Langers D.R.M., De Kleine E., Van Dijk P.
University Medical Center Groningen, Dept. of Otorhinolaryngology, Groningen, The Netherlands

Introduction: A popular hypothesis asserts that tinnitus results from aberrant tonotopic reorganization, for example in response to peripheral hearing loss, which induces an overrepresentation of certain sound frequencies in the brain and thus gives rise to elevated levels of spontaneous activity or synchronicity.

Materials and Methods: In the present study we mapped the tonotopic organization of the auditory cortices in twenty tinnitus patients and twenty matched controls. Functional magnetic resonance imaging was performed to measure the brain response to tone sequences presented at 40 dB HL and ranging from 250 to 8000 Hz.

Results: In spite of some inter-subject variability, the derived tonotopic maps were consistent with previous reports on human tonotopy: multiple tonotopic progressions were found bilaterally on the anterior and posterior banks of Heschl's gyrus. However, no systematic differences were observed between the average maps of the two subjects groups. In particular, no overrepresentation of high sound frequencies was observed. To exclude that differences between groups may have been lost by averaging across

subjects, we performed various statistical analyses. The two groups were shown not to be distinguishable beyond chance.

Conclusion: Our detailed results show that tinnitus in humans is not generally associated with large-scale reorganization of the tonotopic maps in auditory cortex. Although we cannot exclude the existence of subtle or variable reorganizations, or other differences that may have remained undetectable by means of non-invasive neuroimaging, these findings suggest that the hypothesis that tinnitus is caused by cortical plasticity needs to be refined.

FUNCTIONAL CONNECTIVITY NETWORKS IN TINNITUS: THE IMPORTANCE OF BOTHER

Wineland, A.M.[1], Burton, H.[2], Piccirillo, J.F.[1]
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Background: Heterogeneity of tinnitus is recognized but not often considered in the design of human studies. We examined functional connectivity in patients with bothersome and non-bothersome tinnitus by measuring low-frequency (<0.1 Hz) spontaneous blood oxygenation level-dependent (BOLD) signals at rest.

Materials and Methods: Cross-sectional study of eighteen non-bothersome tinnitus (NBT) participants (mean THI 18, range 0 to 24) seventeen bothersome tinnitus (BT) participants (mean THI 53, range 38 to 76) were compared to controls. Functional connectivity of the default mode, attention, auditory, visual, somatosensory, and cognitive networks were analyzed using a seed-based approach.

Results: In BT, negative correlations characterized functional connectivity between auditory and occipital/visual cortex, i.e. BOLD response magnitudes increased in auditory or visual cortex they decreased in the linked visual or auditory cortex. Connectivity for primary visual cortex in BT included negative correlations in the temporoparietal junction and in the inferior frontal gyrus and rostral insula. Rostral insula and inferior frontal gyrus connectivity in tinnitus also showed greater negative correlations in occipital cortex. There were no differences in functional connectivity between the NBT group and the control group.

Conclusions: In BT there was dissociation between activity in the auditory cortex and parts of the visual system and between the attention and executive control networks. Negative correlations in connectivity between these networks could reflect attempts to reduce phantom noise salience. Among NBT, the tinnitus percept does not appear to alter the functional connectivity of the auditory cortex or other key cortical regions.

10:45 a.m. - 12:45 p.m.
SESSION 10:
Auditory & Cognitive changes
Chair: Deborah Hall
Room: Erasmus

GUIDE TO DIAGNOSIS OF THE THREE TYPES OF CHRONIC TINNITUS

Soraya Hoover
Tinnitus – Meniere's – Migraine Clinic, 5151 Katy Fwy 300, Houston TX. 77007, shoover9@aol.com

This presentation will cover the Clinical findings of the 3 TYPES of CHRONIC TINNITUS. Details of correct diagnosis are essential for success in the treatable kinds.

Patients & methods: These findings are arrived at after treating tinnitus sufferers for over 25 years. Present.

Diagnosis & treatment was done following standard Care treatments of oto-rhino-laryngological/ allergy//stress. Calculations are done on the last 2 years of 380 Patients of CHRONIC TINNITUS after excluding those that had obvious otitis media/externa, Cerumen, acoustic neuroma.

Results: Total patients 380. Type 1: 265. Type 2: 90 . Type 3: 115

• Type one: The FLUCTUATING TINNITUS. Good prognosis in treatment.
  1) Gradual onset – may fluctuate in intensity/frequency.
  2) BOTHERS the patient a lot
  3) Usually accompanied with ONE OR MORE of the following:
    Intermittent headaches, vertigo, pressure in the ears, discomfort with loud
    Noise, hyperacidity/heartburn, rhino-sinutis, snoring, sleep apnea.
• Type two: The NONE Fluctuating Tinnitus.
  1) SUDDEN onset, starts and remains constant .
  2) Does not usually bother patients .
  3) Exposure to loud noise (gun-fire- military) OR intake of ototoxic drugs
    (Antibiotics) Kidney failure/meningitis patients.
• Type three: starts as type (2) may get spells of the symptoms of type (1).

All THREE types get extremely aggravated with STRESSFULL life events e.g. – marital/children/ work/ financial/ grief/ unsolved conflicts. The effects of the neuro - immuno - endocrine circuit will be shown and its role.

Outline Summary of treatment will be presented.

Detials of diagnosis & Management of type (1) will follow in ABSTRACT No. 2.

CORRELATION ANALYSIS BETWEEN VISUAL ANALOGIC SCALE INTENSITY (VASI), AND ANNONYANCE(VASA) AND 3 QUESTIONNAIRES STSS (1), TRQ (2) AND THI (3) IN TINNITUS PATIENTS

Esteve-Fraysse MJ, Ohresser M, Holer-Houdoux CH, Branchereau B, Loche V, Pannetier B, Attard A, Geoffray B, Vertallier M, Pantin AS, Lina-Granade G, Levrat F, Nouri N.

Introduction: This is a prospective, multi centric study, 11 investigators in tinnitus referral centers, members of the AFREPA French group (multidisciplinary team setting).

Aim: We aim to compare the results of VASI and VASA with validated questionnaire results for 894 observations.

Material and Methods: The inclusion criterion is debilitating tinnitus as main reason for initial consultation. Patients complete questionnaires and VAS at the first consultation. Exact questions were printed on the back of the scale. The Pearson correlation coefficient and Student's t-test were employed for statistical analysis.

Results: Of 894 cases, 654 had 5 correct tests, 240 at least one incorrect test (238 questionnaires, 2 VAS). The mean VASI was 5.38 + 2.15 and VASA 4.99 +2.32. The correlation coefficients are = (a) between two VAS P<0.001 ; r =0.76 ; (b) VASI/Q1,2,3, is r =0.56 ; 0.5 ; 0.55 ; (c) VASA/Q 1, 2, 3 is r =0.67 ; 0.68 ; 0.70 ; (d) between questionnaires Q1/Q2 r =0.56 ; Q1/Q3 r =0.76 ; Q2/Q3 r =0.70. The partial correlation between VASI and 3 questionnaires is non significant when only residual correlation is analyzed.

Conclusions: The use of scales is easier and less error-prone than the use of questionnaires (2/238) although by referral teams. The correlation between the two scales is highly significant but VASA was found to have a better correlation with 3 questionnaires without different result. We conclude that it represents a useful and rapid tool for a general practitioner evaluation and with minimal risk error for studies when the protocol is to homogenize.

PATIENT AND CLINICAL PERSPECTIVES ON UNANSWERED QUESTIONS ABOUT TINNITUS TREATMENT: THE JAMES LIND ALLIANCE EXPERIENCE

Hall D.A.[1], Wan Mohammed N.[1] and Stockdale D.[2] (on behalf of the Tinnitus Priority Setting Partnership)
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[2] *British Tinnitus Association, Sheffield, UK*

Background: The James Lind Alliance promote two key principles:
• addressing uncertainties about the effects of treatments should become accepted as a much more routine part of clinical practice
• patients, carers and clinicians should work together to agree which uncertainties matter most and deserve priority attention.

Aim: This national project will identify unanswered questions about tinnitus treatment from patient and clinical perspectives and prioritise those that patients and clinicians agree are the most important. This exciting project will help shape the future of tinnitus research in the UK.

Methods and Results: The project was launched in December 2011. A 'harvesting' questionnaire was widely disseminated and people were invited to submit questions about tinnitus assessment, diagnosis or treatment that they would you like answered by research. By the closing date (28 February), we had received 2483 questions submitted by 835 respondents. Patients were well represented (75%), with audiologists and hearing therapists also submitting questions (10%). When completed, the project will publish all uncertainties and highlight the top 10 priorities, shared by patients and clinicians. To achieve this we are currently working to reduce our long list to a short list using a series of systematic mixed methods and will report on our progress at this conference.

Conclusions: Outcomes will contribute to the NHS Evidence UK DUETs (Database of Uncertainties about the Effects of Treatments) collection of treatment uncertainties (part of National Institute for Health and Clinical Excellence, NICE). The results will be widely disseminated to encourage research into the uncertainties.

http://www.tinnitus.org.uk/JLA
http://www.lindalliance.org/JLA_Tinnitus_PSP.asp

ESTABLISHING A HEARING HEALTH IMPROVEMENT NETWORK: THE U.S. DEPARTMENT OF DEFENSE HEARING CENTER OF EXCELLENCE

Mark D. Packer
Executive Director DoD Hearing Center of Excellence

In spite of current hearing conservation efforts, hearing loss and auditory injuries in the Military continue to rise. The scope and magnitude of the effect of war and Military Service on the auditory system validates National Defense Authorization Act (NDAA) requirements to address these injuries, and warrants a vigilant, focused effort to combat them. The Hearing Center of Excellence (HCE) serves as the operational effort to effect the recommendations of a congressionally mandated study through the Institute of Medicine that documented the risk of Military Service on auditory function. The HCE leads a collaborative effort to address prevention, diagnosis, mitigation, treatment and rehabilitation of Tinnitus, hearing loss and auditory system injury, including auditory-vestibular dysfunction related to traumatic brain injury, for the Departement of Defense (DOD) and the Veterans Administration (VA). The Air Force was designated as the Executive Agent with the goal of ensuring optimal DoD, VA, Academic, Industry, and International collaboration. The HCE is thus a health improvement network. Based on the foundation of Information management, outreach and allied research, the ultimate measures of HCE success will be the effect of this networked system on the prevention of hearing loss, collaborative, prioritized research, and the outcomes of the health care delivered to those that suffer auditory injury.

EPIDEMIOLOGY OF NOISE-INDUCED TINNITUS IN ADOLESCENTS

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Background: Adolescents are often exposed to loud music. As a consequence, noise-induced symptoms such as tinnitus, hearing loss and hyperacusis, increased tremendously. Transient (or permanent) tinnitus can be seen as a sign of overexposure and is therefore a valid measure for noise-induced damage.

Objectives: In this epidemiological study we obtained prevalence data of transient and permanent noise induced tinnitus (NIT) in a young Flemish population. In addition we assessed the attitudes towards noise and hearing protection (HP).

Methods: A questionnaire was completed by 3892 high school students (aged 12 to 18; mean 16.7 years old). The prevalence of transient and permanent tinnitus was assessed. Dutch versions of the 'Youth Attitude towards Noise Scale' and the 'Beliefs About Hearing Protection and Hearing Loss' were used. The results of the questionnaires were compared with those of university students (aged 19 to 22; mean: 20.8 years old) previously obtained.

Results: The prevalence of transient NIT and permanent tinnitus in high school students was respectively 74.9% and 18.3%. An increasing trend of transient tinnitus with age

was revealed. Both groups were 'neutral' towards loud music and the use of HP was minimal.

Conclusions: Despite the very high prevalence of tinnitus in such a young population, the rate of HP use and the knowledge about the risks of loud music is extremely low. This study demonstrates that adolescents and young adults are not well informed and show risky behavior related to loud music exposure, providing new insights for future preventive measures.

Acknowledgements: We thank the Stavros Niarchos Foundation for the financial support for tinnitus research.

THE EFFECTS OF TINNITUS ON WORKING MEMORY

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[2] *Royal National Throat, Nose & Ear Hospital, Royal Free Hampstead NHS trust, London, UK*

Introduction: The literature suggests that up to 70% of tinnitus patients do report having difficulties with concentration1, this being the third highest reported difficulty associated with tinnitus. However, only a small number of studies have focused on the effects of tinnitus on cognitive functioning by using experimental methods.

Aims: To investigate the effects of tinnitus on information processing, working memory and attention by examining performance on experimental tasks in tinnitus patients and healthy controls. The relationship between self-reported cognitive difficulties, emotional state and objective measures of task performance on working memory tasks were also studied.

Methods: Forty one subjects (21 tinnitus patients, 20 healthy controls) participated in the study. All participants completed 3 experimental tasks (single auditory, single visual, dual) under two conditions (with and without the presence of white noise). Several questionnaires were administered in order to obtain self-reported levels of cognitive difficulties, emotional state, and white noise related distress. Results Tinnitus group showed impaired performance on the single and dual working memory tasks compared to controls which could not have been explained by emotional distress. Tinnitus patients performed worse in terms of accuracy which was particularly evident on the auditory tasks. Tinnitus patients were also found to show a positive association between higher level of white noise distress and worse accuracy.

Conclusions: The results support the notion that tinnitus patients do have objective memory and attentional difficulties. Tinnitus also seems to be implicated in capturing attention as well as having an interfering effect on working memory.

Reference:
1 Andersson , G., Lyttkens, L. & Larsen, H.C. (1999) Distinguishing levels of tinnitus distress. Clin Otolaryngol , 24, 404-410.

DECREASED SOUND TOLERANCE (HYPERACUSIS AND MISOPHONIA): CLINICAL IMPLICATIONS

Margaret M. Jastreboff[1] & Pawel J. Jastreboff[2]
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Decreased Sound Tolerance (DST) is a common problem. Subjects exhibit negative reactions (e.g., discomfort, annoyance, anxiety, pain) as a result of exposure to every-day sounds that would not evoke such aversive reactions in the average listener. DST results from combination of hyperacusis and misophonia. While at the behavioral level effects of hyperacusis and misophonia are similar, their mechanisms are distinctively different and require independent treatments. In hyperacusis, the intensity of the negative reaction is determined solely by the physical characteristics of the offending sound, e.g., its spectrum and intensity; the context in which the sound occurs, and its subjective meaning, are not important. In 2000 we recognized that many patients exhibiting DST reacted negatively only to specific patterns of sound while being able to tolerate loud sounds. Therefore, we coined the new term, misophonia, to describe this subtype of DST. In misophonia reactions to sound are NOT simply related to physical parameters of a sound, but depend on previous association with a bothersome sound and the context in which the sound occurs. Tinnitus Retraining Therapy (TRT) is an effective treatment option for both DST. The desensitization protocols, and sound protocols which create positive associations with variety of sounds, are used for hyperacusis and misophonia, respectively. Case presentation will be used to illustrate the differences between the treatment approaches for hyperacusis and misophonia. The proper diagnosis and treatment of hyperacusis and/or misophonia frequently result in complete resolution of DST in affected patients.

DOES TINNITUS AFFECT SPEECH PERCEPTION IN THE CONTRALATERAL EAR IN PATIENTS SUFFERING FROM SINGLE-SIDED DEAFNESS TREATED BY COCHLEAR IMPLANTATION?

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Background: In previous studies tinnitus is often suggested to interfere with speech comprehension. One recurrent shortcoming in comparing speech perception between patients with different degrees of tinnitus is the contribution of accompanying hearing loss.
The most direct solution to this problem is to compare intra-individual speech perception, by manipulating the degree of tinnitus. Since cochlear implantation has proved to be an effective and stable treatment for tinnitus, intra-individual comparison is possible in our study group.

Purpose: The aim of the study was to investigate whether the degree of tinnitus affects speech perception in the contralateral ear in patients suffering from single-sided deafness treated by cochlear implantation.

Methods and patients: 20 subjects suffering from single-sided deafness and ipsilateral incapacitating tinnitus received a CI. The study compares intra-individual speech perception in the (near) normal hearing ear using an insert phone and with the CI in the contralateral ear switched on and off. The mean VAS score with CI switched on is 3.82, and with CI switched off 8.27.

Results: The average speech reception threshold in the (near) normal ear is -4,60 dB SNR when the CI is switched off. Compared with the CI on condition, there is no significant difference (-5,82 dB SNR).

Conclusion: We conclude that the degree of tinnitus does not affect the speech perception in the contralateral (near) normal hearing ear in patients suffering from singe-sided deafness treated by cochlear implantation.

1:45 - 3:00 p.m.
PLENARY TALKS

1:45 - 2:30 p.m. – Keynote Speaker
NIHIL NOVE SUB SOLE: FILLING IN THE BOXES OF THE NEUROPHYSIOLOGICAL TINNITUS MODEL

Pawel Jastreboff
Pawel Jastreboff is generally accepted as one of the godfathers of tinnitus research. He received a Ph.D. in Neuroscience and Doctor of Sciences Degree (Neuroscience) from the Polish Academy of Science. He did his Postdoctoral training at the University of Tokyo, Japan. After 8 years at Yale University and 8 years at University of Maryland, where he established Tinnitus & Hyperacusis Center he moved to Emory University in January 1999 to continue his research on tinnitus and to create Emory Tinnitus & Hyperacusis Center - a center of excellence for tinnitus research and patients treatment. He holds Visiting Professor appointments at Yale University School of Medicine and at University College London and Middlesex Hospital, London, England. In 1988, on the basis of his seminal research on the physiological mechanisms of tinnitus he proposed a neurophysiological model of tinnitus and proposed a treatment derived from this model, the well-known Tinnitus Retraining Therapy (TRT). He has also created an animal model of tinnitus, and his present research is aimed at delineating the mechanisms of tinnitus and designing new methods of tinnitus and hyperacusis alleviation.

A number of tinnitus models have been proposed based on variety of experimental findings and assumptions. The models should be verified by assessing how well existing experimental and clinical data are explained by a model, and checking correctness of predictions based on a model. One of the significant problems hindering this work is large disparity of results in tinnitus research (e.g., neuroimaging). In 1990 the neurophysiological model of tinnitus has been introduced. The model proposed that the auditory system plays a secondary role in clinically-relevant (bothersome) tinnitus and that other systems in the brain are dominant. The limbic and autonomic nervous systems were indicated as important, while not the only one involved. Notably, the model guides the analysis of tinnitus and points out a series of issues to consider, which may be responsible for incongruity of results and their interpretation. Specifically: 1) impact of the tinnitus-related neuronal activity being coded in temporal patterns of single unit discharges rather then being a general increase of neuronal activity; 2) distinguishing between mechanisms and the brain areas involved in tinnitus perception vs. mechanisms and areas involved in tinnitus-evoked negative reactions; 3) dominant role of the strength of functional connections rather than function of the brain centers linked by these connections; 4) implication of conditioned reflexes governing these connections; 5) significant role of subconscious brain centers; 6) all existing animal models are sensitive only to tinnitus perception. The ramifications of these issues will be presented, together with discussion of how the neurophysiological model of tinnitus may explain current controversies and how other models could be aligned with it.

2:30 - 3:00 p.m.
CLOSING SESSION

Berthold Langguth
As a neurologist, psychiatrist and pain specialist Berthold Langguth is one of the most prolific writers on all aspects of tinnitus. He has published more than 75 pubmed listed papers on tinnitus, 40 bookchapters, and co-edited 2 books on the same topic. He studied in the USA, Switzerland and China and sponsored by and with help from Dr de Nora the Tinnitus Research Initiative was created, which promoted explorative and solidifying tinnitus research. He chaired the TRI from its foundation till now and has been very successful in setting up multiple international collaborative multidisciplinary research initiatives to combat this enigmatic symptom. His incredible stamina, open-mindedness and intelligence have been very instrumental in motivating lots of other people to take up investigating tinnitus.

INDEX OF AUTHORS