Tinnitus research update 2013-2014

Dr Roland Schaette is the former BTA Senior Research Fellow at University College London (UCL), a post funded by the British Tinnitus Association for the past five years. Here he talks about progress made in tinnitus research over the past 12 months.

What progress has there been in the understanding of tinnitus in the past year?

In the past year, several important studies have been published that have advanced our understanding of the mechanisms of tinnitus. For example, several detailed studies on animal models of tinnitus have managed to show that the occurrence of tinnitus could be due to specific changes in the activity of nerve cells in the brain. It was observed that in animals with tinnitus, nerve cells in the auditory brainstem (i.e. the first processing stages of the auditory pathway) showed increased activity even when there was no sound present (Dehmel et al., 2012; Li et al., 2013). One of the studies also demonstrated that acute noise-induced tinnitus could be prevented from developing into chronic tinnitus when a drug was administered shortly after noise exposure (Li et al., 2013), suggesting new ways for the treatment of acute tinnitus through timely interventions.

Research in the past years has managed to demonstrate a tight relation between hearing loss and tinnitus. However, one of the questions that has remained puzzling for tinnitus researchers is why hearing loss does not always lead to tinnitus, even though hearing damage might be the main trigger for tinnitus. This question has been addressed by a team from the University of Essex through a very detailed investigation of the hearing status of hearing-impaired patients with and without tinnitus. By using tests that went far beyond standard audiological assessment, they could show that the group with tinnitus showed a different pattern of hearing damage than the group without tinnitus (Tan et al., 2013). These new data fit well with our earlier results on the relation between tinnitus and hearing loss (König et al., 2006), and also with our recent results from tinnitus patients without apparent hearing loss, where we could demonstrate signs of damage to the same parts of the hearing apparatus (Schaette and McAlpine, 2011). In the future, it might be possible to design treatment approaches that compensate more directly for these specific hearing deficits, in order to provide greater tinnitus relief.

Hearing aids are often used in tinnitus treatment, but their effects can vary from patient to patient. Factors that influence the outcome of tinnitus treatment with hearing aids have now been investigated in a study from New Zealand. The greatest treatment effect was seen in those patients

PRESS ENQUIRIES
Please contact Emily Broomhead or Nic Wray at the BTA office on 0114 250 9933
email emily@tinnitus.org.uk or nic@tinnitus.org.uk
Out of office hours call Nic Wray on 07816 827304

that reported complete masking of their tinnitus when the hearing aid was switched on. Complete masking was

predominantly seen in patients where the tinnitus frequency fell into the range of frequencies stimulated by the hearing aid (McNeill et al., 2012), suggesting that the hearing aid simply might not have provided effective stimulation to the nerve cells generating the tinnitus in the other cases. Moreover, hearing aids may not be equally effective for each type of hearing damage. We have recently shown that tinnitus patients might often have hearing damage where restricted frequency regions close to the tinnitus frequency drop out completely. In these cases, it will be very difficult to compensate for the hearing loss through a hearing aid (Kiani et al., 2013), which could explain why hearing aids not always provide tinnitus relief. These results have demonstrated that detailed assessment of hearing status and tinnitus characteristics might be helpful for understanding the effects of tinnitus treatments better, and for targeting treatments at the right group of patients.

What remains unknown about tinnitus and it causes?

Even though recent research results have answered several important questions about tinnitus, we have not yet found all pieces to the puzzle. We are getting close to understanding which plasticity mechanisms in the brain play a key role in the development of tinnitus, but significant research effort is still required for clarifying in detail how these mechanisms are triggered and regulated. Progress on these aspects will elucidate how these plasticity mechanisms can be targeted selectively, in order to eliminate tinnitus without side-effects. Another open question is why hearing loss does not always lead to tinnitus, even though hearing loss can be identified as a trigger for tinnitus in most cases. As mentioned above, we have seen progress on this recently, with the identification of differences between tinnitus patients with hearing loss and patients with hearing loss but not tinnitus. A deeper understanding of the factors that determine whether hearing damage gives rise to tinnitus will lead to new ways of treating tinnitus.

What specific aspects of tinnitus are you researching in 2014?

In the coming year, my team and I will be focussing our research efforts on several key questions. Firstly, we will continue our investigations on why hearing loss does not always lead to tinnitus. Secondly, we will study phantom sounds that can arise while hearing loss is simulated through an earplug in more detail. Thirdly, we will assess the relation between tinnitus and hyperacusis, since patients are often affected by both conditions. We will use an integrated approach that combines experimental investigations with computer modelling for all these aspects.

PRESS ENQUIRIES
Please contact Emily Broomhead or Nic Wray at the BTA office on 0114 250 9933
email emily@tinnitus.org.uk or nic@tinnitus.org.uk
Out of office hours call Nic Wray on 07816 827304

When is a cure for tinnitus likely to be developed?

I believe that we are getting closer to developing a cure for tinnitus, since intensive research efforts during the past decade have laid a solid foundation upon which translational research can now start to build up. We are really beginning to understand what happens in the brain when tinnitus develops, and the latest animal studies have highlighted potential targets that might be amenable to specific interventions. It now looks like it will be possible to develop a pill for tinnitus, or to alleviate tinnitus through specific acoustic and electric stimulation paradigms with long-lasting effects. It is difficult to predict when exactly these approaches will make the transition from basic science to clinical studies and beyond, since the devil might be in the detail and more research is still needed, but I am optimistic that it will be in the not too distant future.

References:

Dehmel S, Pradhan S, Koehler S, Bledsoe S, Shore S (2012) Noise overexposure alters long-term somatosensory-auditory processing in the dorsal cochlear nucleus--possible basis for tinnitus-related hyperactivity? J Neurosci 32:1660-1671.

Kiani F, Yoganantha U, Tan CM, Meddis R, Schaette R (2013) Off-frequency listening in subjects with chronic tinnitus. Hear Res.

König O, Schaette R, Kempter R, Gross M (2006) Course of hearing loss and occurrence of tinnitus. Hear Res 221:59-64.

Li S, Choi V, Tzounopoulos T (2013) Pathogenic plasticity of Kv7.2/3 channel activity is essential for the induction of tinnitus. Proc Natl Acad Sci U S A 110:9980-9985.

McNeill C, Tavora-Vieira D, Alnafjan F, Searchfield GD, Welch D (2012) Tinnitus pitch, masking, and the effectiveness of hearing aids for tinnitus therapy. Int J Audiol 51:914-919.

Schaette R, McAlpine D (2011) Tinnitus with a normal audiogram: physiological evidence for hidden hearing loss and computational model. J Neurosci 31:13452-13457.

Tan CM, Lecluyse W, McFerran D, Meddis R (2013) Tinnitus and patterns of hearing loss. Journal of the Association for Research in Otolaryngology : JARO 14:275-282.

PRESS ENQUIRIES

Please contact Emily Broomhead or Nic Wray at the BTA office on 0114 250 9933

email emily@tinnitus.org.uk or nic@tinnitus.org.uk

Out of office hours call Nic Wray on 07816 827304

PRESS ENQUIRIES
Please contact Emily Broomhead or Nic Wray at the BTA office on 0114 250 9933
email emily@tinnitus.org.uk or nic@tinnitus.org.uk
Out of office hours call Nic Wray on 07816 827304