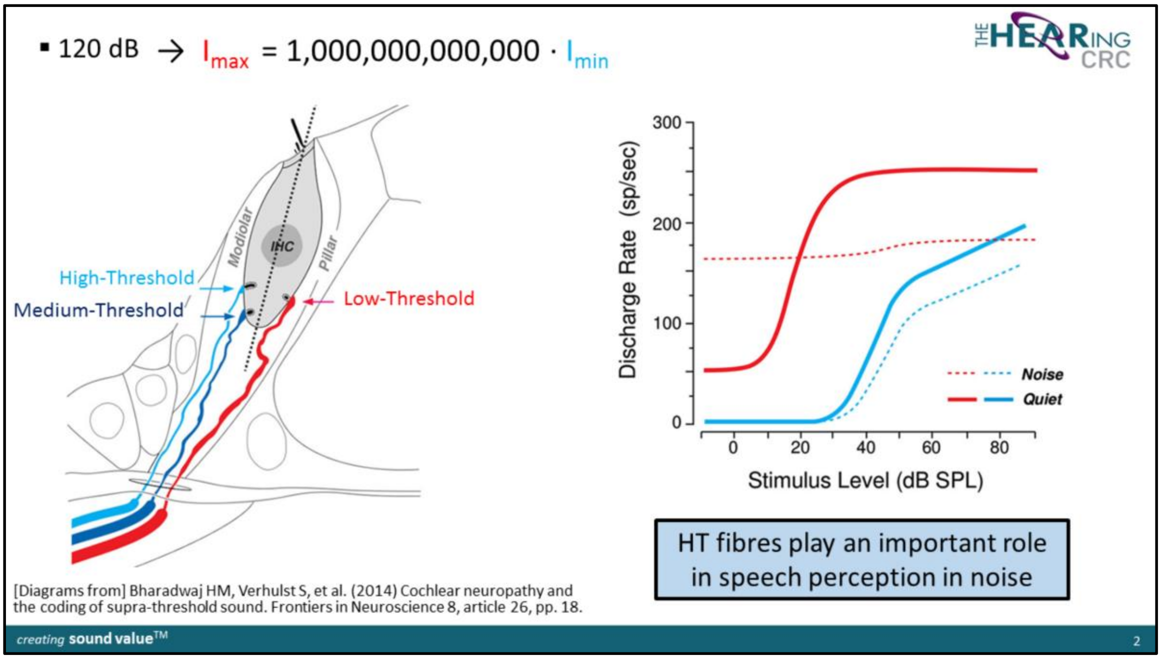
- Good morning, I am Joaquin Valderrama, from the National Acoustic Laboratories.

- It is for me a pleasure and an honour to present here at this conference the main results of our current research.

- In this presentation, I will talk about some neural mechanisms involved in such a complex process as it is understanding speech in noise, and more in particular, about hidden hearing loss.

- Let me start this talk by highlighting something extraordinary of our auditory system. It is something that we all know, but still it is extraordinary.



- We are able to perceive a range of intensity levels of 120 dB. Sometimes we forget that the maximum level we are able to perceive is 1 trillion (1000 billion) times the softest sound. And even more surprisingly, we are able to perceive differences of level of 1 dB all along this range.

- This requires a very sophisticated structure, that we don't completely understand.

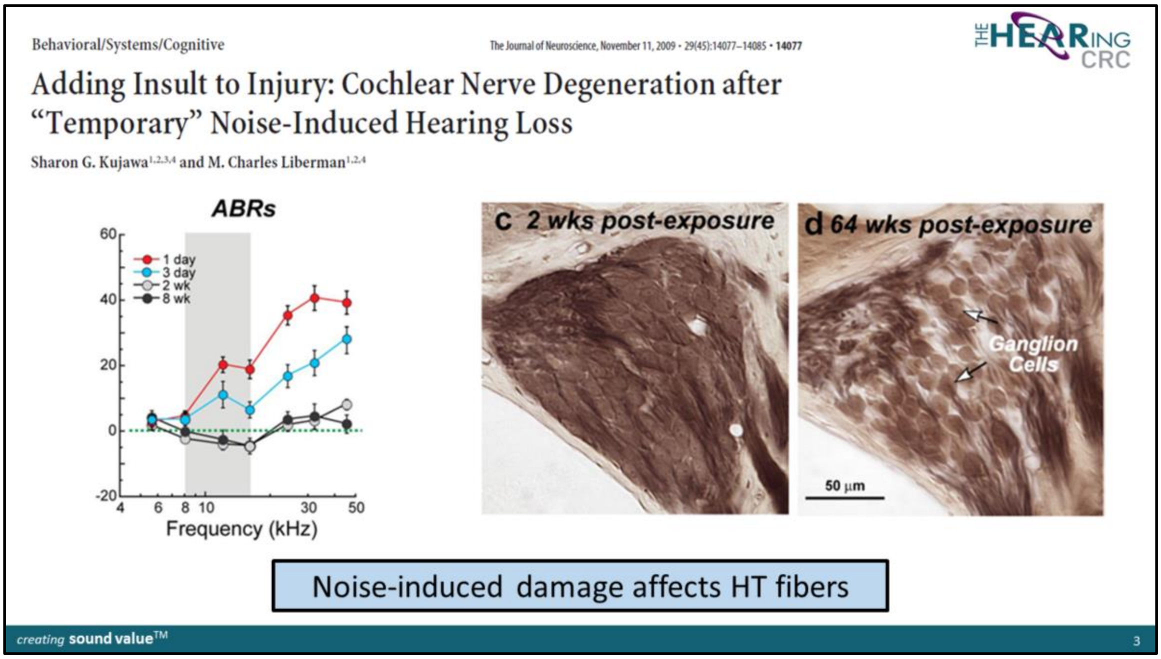
- One of the mechanisms involved in encoding such large range of levels is the existence of auditory nerve fibres of different characteristics.

- The Low-threshold (LT) fibres, presented in red colour in this diagram, are able to encode soft sounds in quiet, and they saturate when medium and high level sounds are presented.

- On the other extreme, the High-threshold (HT) fibres, in light-blue, are able to encode higher levels of sounds.

- The MT are fibres with characteristics in between the LT and the HT.

- From all these fibres, the HT play a very important role in understanding speech in noise. This figure shows that, under the presence of noise, only the HT fibres are able to encode information, since the LT are desynchronized.



- Let me present a summary of a study that has influenced our research.

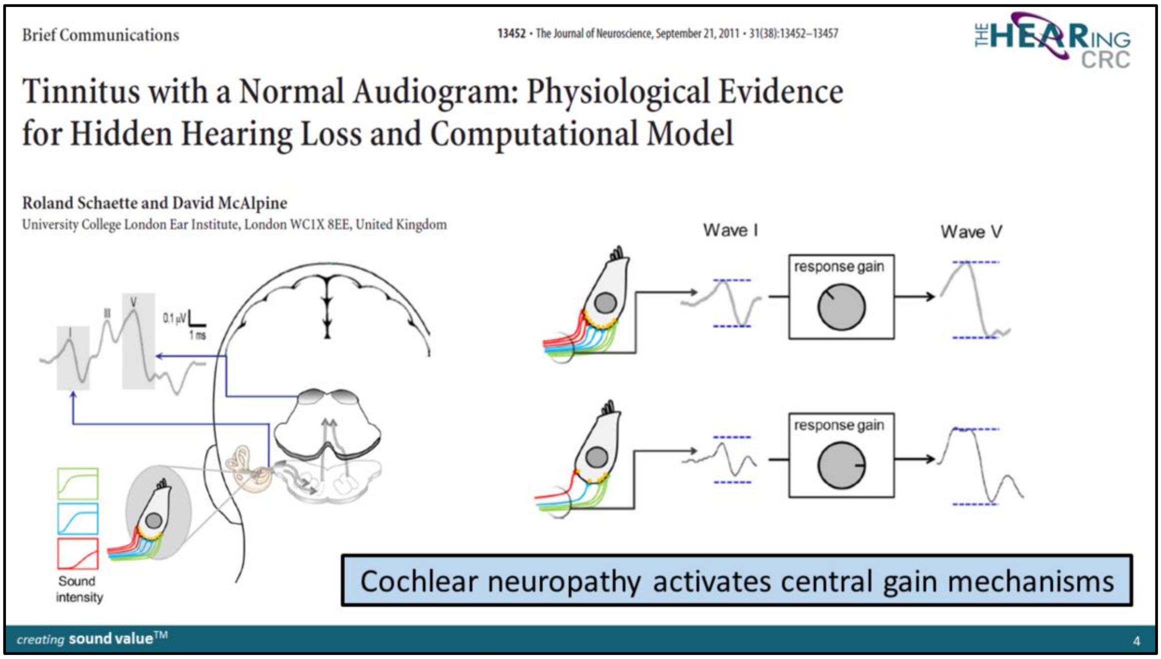
- In this study, Kujawa and Liberman carried out an animal study in Young-healthy anaestesized mice. They presented filtered noise at 100 dB during 2 hours.

- 100 dB is a loud noise, but it is a level that you could easily find in many leisure activities, such as in a rock concert or in a F1 racing.

- They found that one day after the test, the thresholds of the OAE, ABR and CAEP increased (their hearing was worse), but these thresholds recovered after few weeks.

- However, when they inspected the auditory nerve, they observed that noise-exposure led to an irreversible loss of primary neurons, and more in particular, to a loss of HT fibres.

- These results inspired a theory in which many people with problems in understanding SPIN would present a normal audiogram, leading to a hidden hearing loss. Hidden, because there are no tests available to evaluate the state of these type of neurons.



- This was in animals, in humans, Schaette and McAlpine observed the waves I and V as indicators of the state of the neurons in the cochlea and in the midbrain, a more central stage of the auditory pathway.

- Compared to normal hearers, they observed that cochlear damage led to a reduced wave I (as a consequence of less fibres contributing to the response), but equal-amplitude wave V, as a consequence of the activation of central gain mechanisms that compensate the reduced output from the cochlea.

- These two studies have influenced the approach of our research, which was to improve our understanding of the neural mechanisms that participate in understanding speech in noise. We believe that understanding these mechanisms is essential to provide efficient strategies that will eventually improve the quality of life of many people.

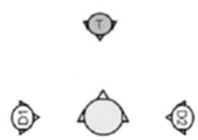
- So, what did we do?

Methods

- ABR
  - ✓ Fz-M2
  - ✓ 10,000 clicks, condensation
  - ✓ Rate 39,1 Hz

  a. 75 dB HL in Quiet
  b. 75 dB HL in Noise (55 dB SPL)

- Speech perception in noise
  - ✓ LiSN-S



- Subjects
  - Pilot
    - ✓ 13 subjects (6 males, 44±7 yr)
  - Full set
    - ✓ 42 subjects (21 males, 45±7 yr)

✓ Hypothesis

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- We recorded ABR signals using 10,000 clicks in condensation polarity, presented at a standard rate of 39.1 Hz.

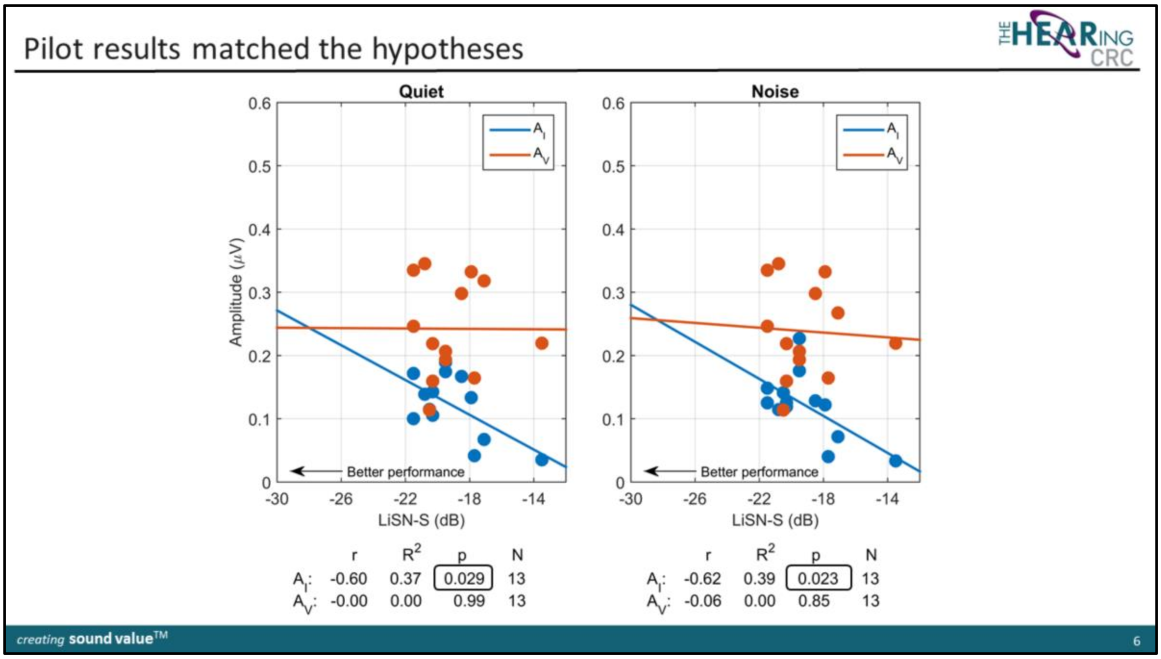
- We measured the amplitudes and latencies of the main components: waves I, III and V.

- We did this test in these two conditions, for a double purpose. On one hand, to evaluate the reproducibility of our results, and on the other, to evaluate whether or not inserting some level of noise would make the analysis more sensitive.

- We measured the ability to understand speech in noise through the LiSN-S test, which evaluates the ability of a subject to separate a target source from distractors placed in different positions.

- We tested a pilot of 13 subjects by the time of the submission of the abstract, and since then, we have collected data from a full set of 42 subjects.

- Our hypothesis is that the ability to understand speech in noise would correlate with the amplitude of wave I, as a consequence of lower number of fibres contributing, but not on the wave V, because the activation of the central gain mechanisms.

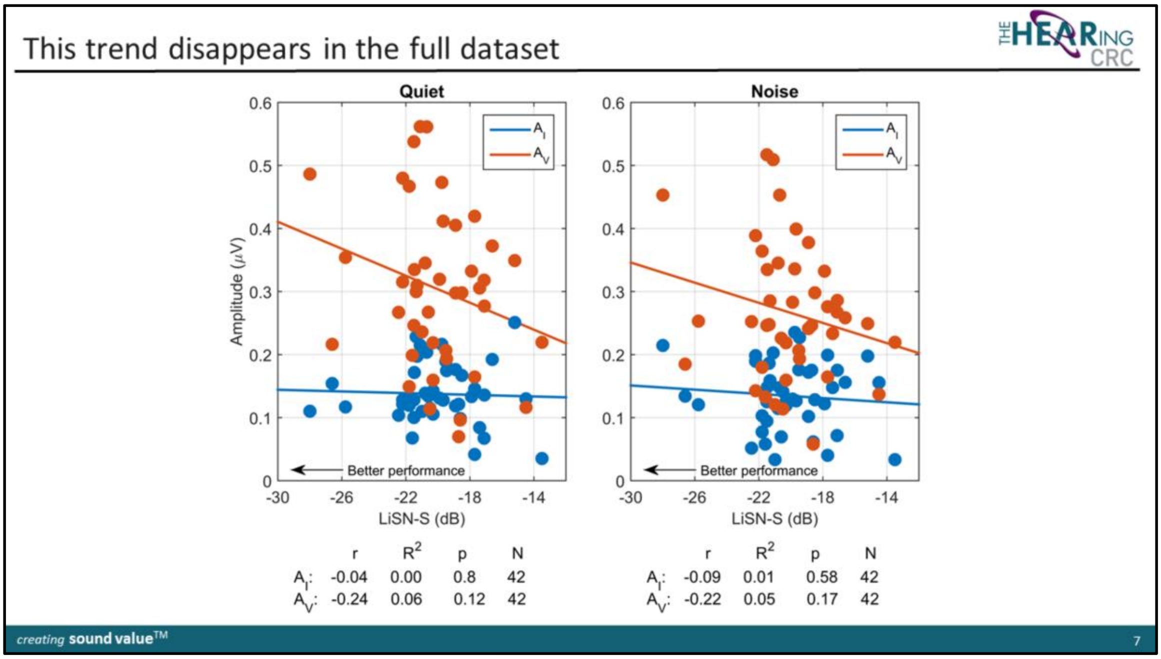


- Analysis of the pilot data showed results consistent with our hypothesis.

- These figures show the amplitude of waves I (in blue) and V (in red) recorded in the pilot set of subjects, in quiet and in noise.

- These figures show significant correlations (with a p-value lower than 0.05) between the wave I amplitude and the performance of speech in noise test. Better performance (or lower thresholds) correlate with higher-amplitudes of the wave I.

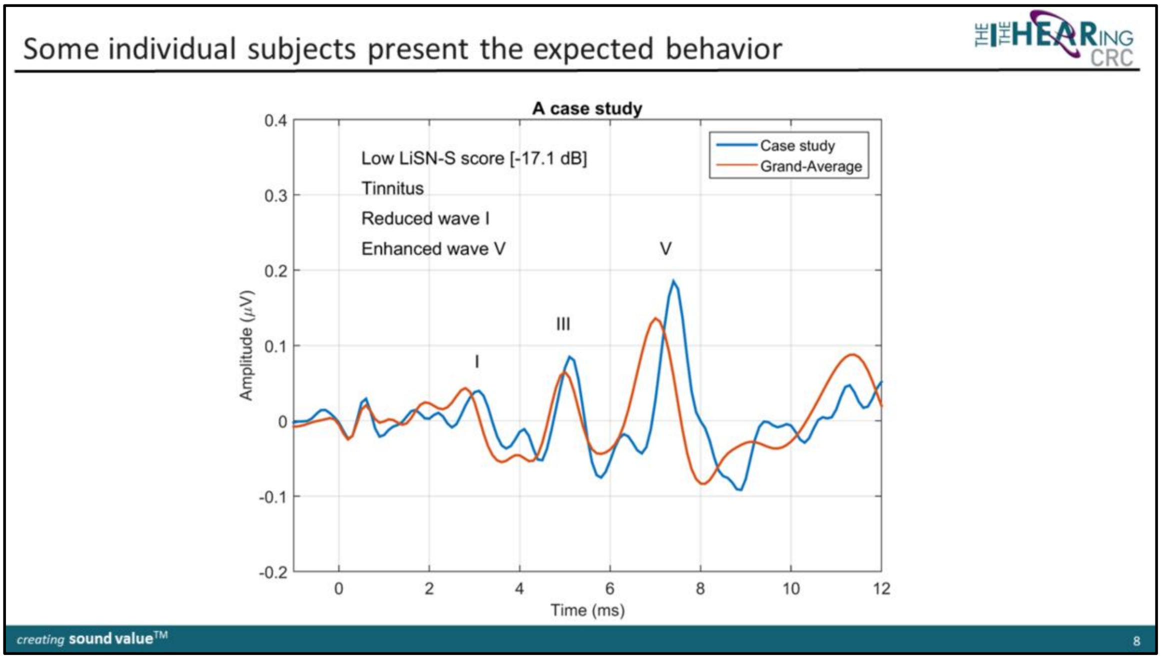
- Regarding wave V, we did not observe any correlation, as we were expecting.



- However, when we put together the data from the full data set, the trend disappears. We believe this could be a consequence of a very large inter-subject variability.

- Understanding speech in noise is indeed a very challenging activity, which involves several processes: it’s not only hidden hearing loss, but also binaural processing of sounds and other cognitive abilities such as language, working memory, attention, etc.

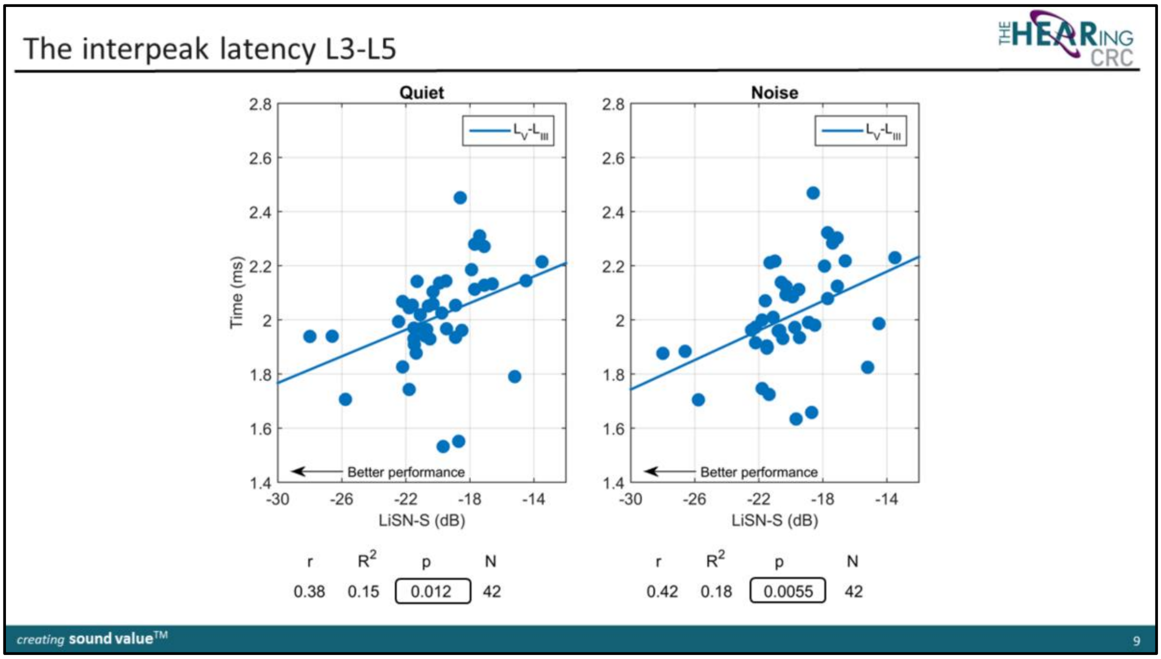
- In the future, we will continue collecting data trying to factor some of these processes out in order to get a more clear idea of the neural mechanisms involving each of them.



- Taking a closer look to individual data, we found subjects accomplishing our hypothesis of hidden hearing loss.

- This case study shows a subject with a very low score on the LiSN-S test, with reported tinnitus, with lower wave I amplitude compared to the grand-average, and larger wave V amplitude.

- This is just a simple case, so at this moment, we can’t draw any determining conclusion.



- On top of this, we found a significant correlation between the performance of the LiSN-S test and the interpeak latency of waves III and V.

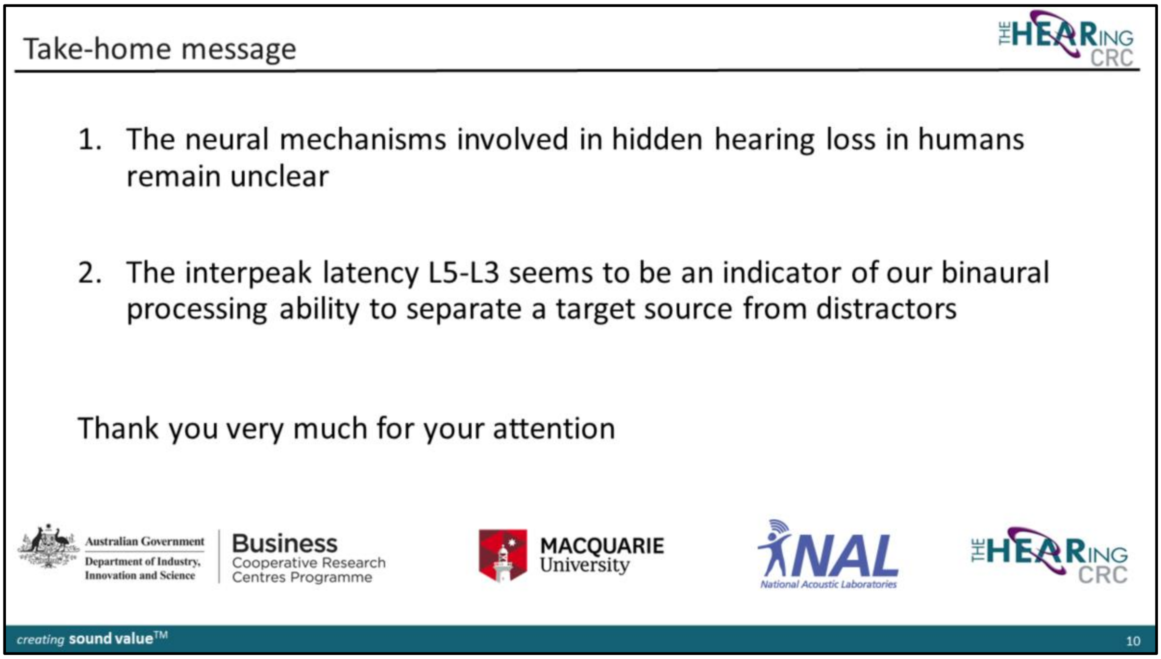
- These two figures show that the results were reproduced by both in quiet and in noise scenarios.

- These results point out that the transmission time between the superior-olivar-complex and the midbrain may play an important role in relevant tasks for understanding speech in noise, such as the ability to separate a target from distractors.

- These results are in accordance with the role of the SOC, which is in the MSO and in the LSO where the brainstem evaluates inter-time and inter-level differences perceived between both ears.

- These results are inspiring new research questions as: what may influence the transmission time between these two stations? Could maybe that the state of the myelin of the neurons in this stage be a critical parameter to understand speech-in-noise?

- We will also try to give answers to these questions in the future.



- I would like to finalise by highligting the two main “take-home messages” of this talk. [Read]

- Thank you very much for your attention.