Re-training perception of speech in noise using on-line training

Lancaster University Centre for Ageing Research
Town and Gown Event – 27 September 2018
• 1. Introduction to the Problem
• 2. Listening to speech in challenging situations
• 3. A model of language understanding
• 4. Improving the understanding of speech-in-noise.
• 5. Summary
• 6. Questions
Why is communication/interaction important?

• Lack of social interaction and hearing loss have both been demonstrated (amongst others) as potential risk factors for dementia for older individuals (Livingston et al., 2017).

• Lin et al. (2013) reported on the link between hearing loss and cognitive decline/dementia in the Baltimore Longitudinal Study of Ageing (BLSA).

• Participants in the Lin study had their average hearing thresholds measured at Year 5 of this longitudinal study. They additionally had cognitive assessments at Years 5, 8, 10 and 11. When measured at baseline (Year 5), those participants who were identified as belonging to a group having normal hearing in the better ear performed significantly better on a global cognitive test battery when compared to the group with hearing loss.

• A report from Washington county that explored Atherosclerosis risk (Deal et al., 2015) identified a greater risk of accelerated cognitive decline for participants that had hearing loss compared to those that did not. It was also demonstrated that the decline was modifiable, to some extent, if a hearing aid was worn.

• The link between age-related hearing loss and cognitive decline was explored in a review of potential causal mechanisms (Wayne & Johnsrude, 2015).
Perceiving speech-in-noise and other types of degraded speech transmission?

• Challenging listening conditions may include many different types of scenarios.
• 1. Source degradation – faster speech rate, syllable deletion
• 2. Source degradation (2) – accented speech, disfluencies, speech disorders
• 4. Environmental/transmission degradation – distance, interference of masking.

Speech recognition in adverse conditions: A review. 2012 Mattys et al.
The ease of Language Understanding (ELU) model, 2013, Ronnberg et al.,
How, therefore, can we improve things?

- We could perform auditory training.
  
  - Auditory training can be defined as “a systematic procedure designed to increase the amount of information that a person’s hearing contributes to his total perception” (Sanders, 1971).

  - Analytic auditory training is an approach that requires the trainee to make judgements on the recognition of speech sounds, for example between syllables/phonemes (Ferguson, Henshaw, Clark, & Moore, 2014).

  - The choice could also be making a decision between similar words.

  - It is also known as bottom up training – we can do this on-line.

- [BrainHQ log in](#)
How, therefore, can we improve things?

- We can also do synthetic training.

- This is where more sentence based training is used recruiting cognitive and top down semantic knowledge to assist with word closure.

- This is a sample sentence with a ‘pop’ out training effect

- This can also be performed on-line as part of a communication training package.

- [LACE demo](#)
What else could we train?

• In a comprehensive report of cognitive functions and speech-in-noise performance, there was a conclusion that the review had ‘clearly demonstrated that there is a link between cognition and speech reception in noise’ (Akeroyd, 2008).

• The review classified the cognitive measures into a) general scholastic ability, b) standard IQ tests and tests of memory, c) tests of working memory, d) miscellaneous tests, e) simple and choice reaction times and f) visual analogues of speech reception.

• Of the above, three cognitive areas that have demonstrated a relationship with speech-in-noise performance have been working memory, speed of information processing (processing speed, simple and choice reaction times) and control of inhibition.
An example of the relationship between speech-in-noise performance and response latency

The above is one example of a relationship of speech-in-noise performance with a response latency task.

It therefore seems reasonable that if information processing speed influences speech-in-noise performance then training to improve processing speed may make performance better.

The same may hold for other cognitive functions as well.
Other cognitive functions to consider training

- Complex/simple working memory tasks – Listening/Reading span.

- Tests of control of prepotent inhibition - Stroop

- Test of real time inhibition control

- Can we train these on-line?

- Yes. There are many on-line training programs you can use.

- Many are aimed at cognitive health in general and many come in the form of games where you may not know training is taking place.
Does on-line auditory training improve speech-in-noise performance?

- In similar fashion to the previous slide, research using synthetic auditory training improves on-task performance (Richards and Holland).
Does on-line cognitive training improve speech-in-noise performance?

- There is a pattern on-line cognitively trained groups performing cognitive tasks in superior fashion after training when compared to control groups (Richards and Holland).

- There is a further pattern that to achieve the best performance training should be sensory modality specific.

There is some evidence that this may allow for improved performance of a speech-in-task, or that if training gains are sought auditory training of cognitive tasks offers the greatest improvement.
Summary

- On-line training can improve speech-in-noise performance but gains are mainly on-task, although there is evidence that transfer to other speech tasks can be achieved. This transfer is best achieved when both the training and the task are challenging.

- Transfer to improved performance of associated tasks is also achievable but only when training is challenging and outcomes are measured in the sensory modality of the training.

- Auditory training is able to achieve the best improvement in speech-in-noise performance as access to audition is the dominant factor.

- The success of the training of cognitive functions to improve speech-in-noise performance is harder to evidence as they play a less significant (but potentially no less important) role in perceiving speech-in-noise.

- The type of training appears to play a key role in the success of a training program, so assessments to identify auditory/cognitive weaknesses should be a key in designing any training package.

- The role of undertaking the cognitive training itself has a potential additional benefit for an individual.
Thank you for listening.
Questions?