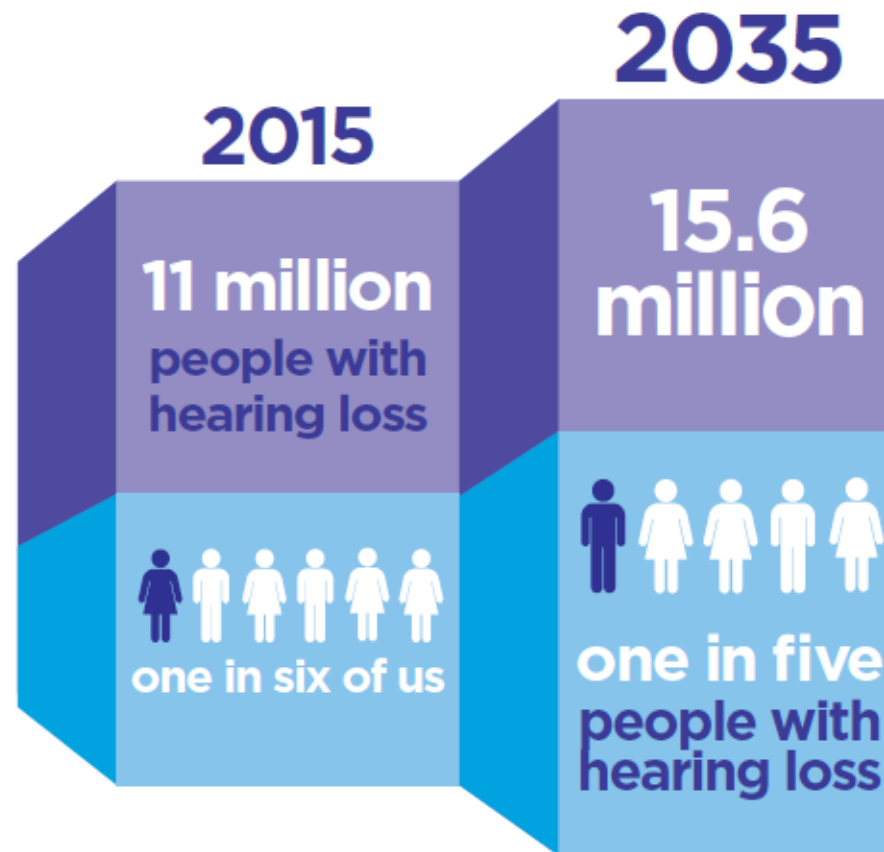


# Ear trumpets to machine learning: Putting the AI into Hearing (AI)ds

Dr Alinka Greasley  
Associate Professor of Music Psychology  
School of Music  
University of Leeds

# Prevalence of hearing loss in the UK

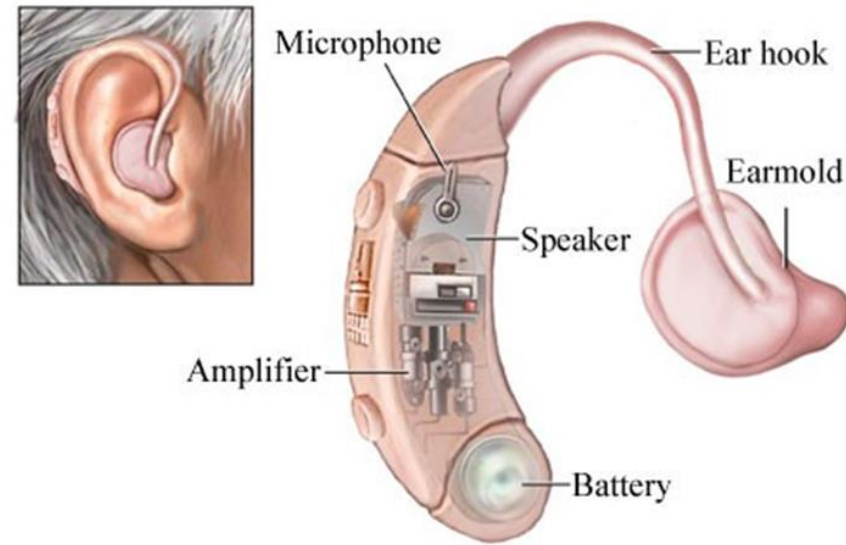


# Affect of hearing loss on quality of life

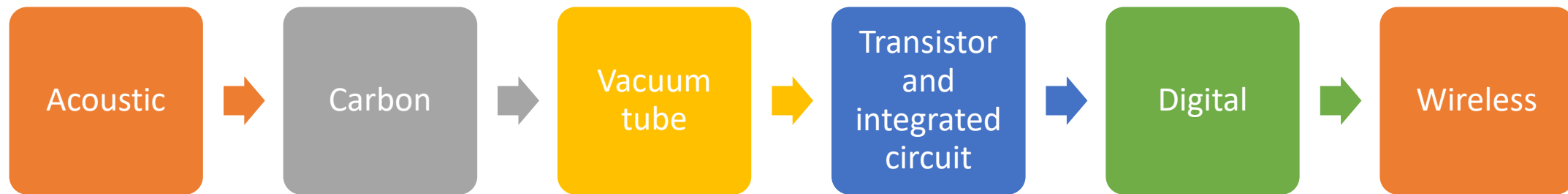
- Psychological and social effects ([Lamb & Archbold, 2016](#))
  - Difficulty communicating with people
  - Withdrawal from social activities
  - Isolation, loneliness
  - Decline in general health
- High personal, societal and economic costs ([Dept. of Health, March 2015](#))
  - £30b annually
  - Lost productivity
  - Higher unemployment

# Hearing aid technology

- HAs work by enhancing sounds to make them louder and clearer
- Designed to identify and amplify speech rather than background noise
- Decrease negative psychosocial effects of hearing loss



# History of hearing aid development



Dillon (2012) *Hearing Aids* (2<sup>nd</sup> Ed.) Boomerang Press.

Acoustic



Beethoven's Small Ear Trumpet  
Made by Johann Nepomuk Mazel  
(1772-1838). c. 1812 – 1813.

BEETHOVEN-HAUS  
BONN



'Opera comb' hearing aid c.1870



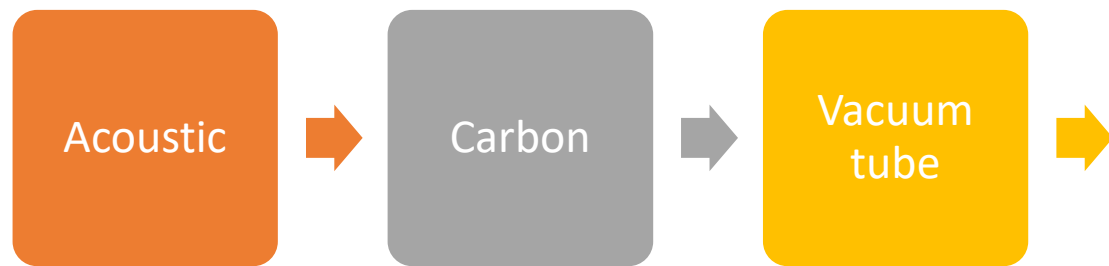
Acoustic



Carbon

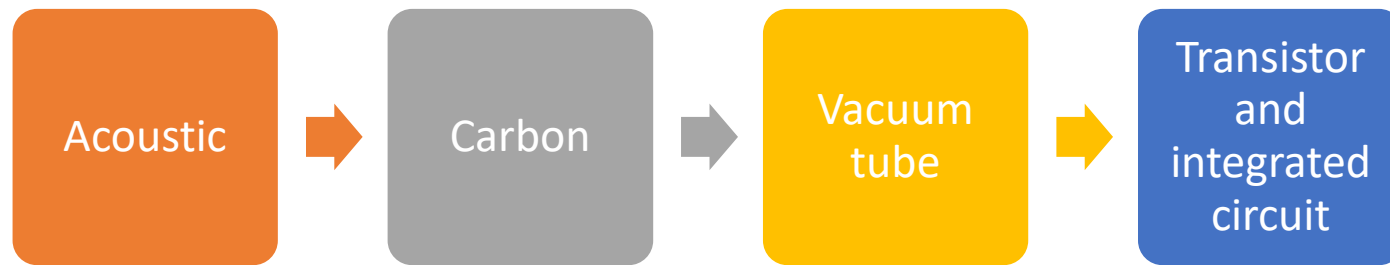


Acousticon Model C8, c. 1899  
1937 by Dictograph Products, Inc. of New York, NY.

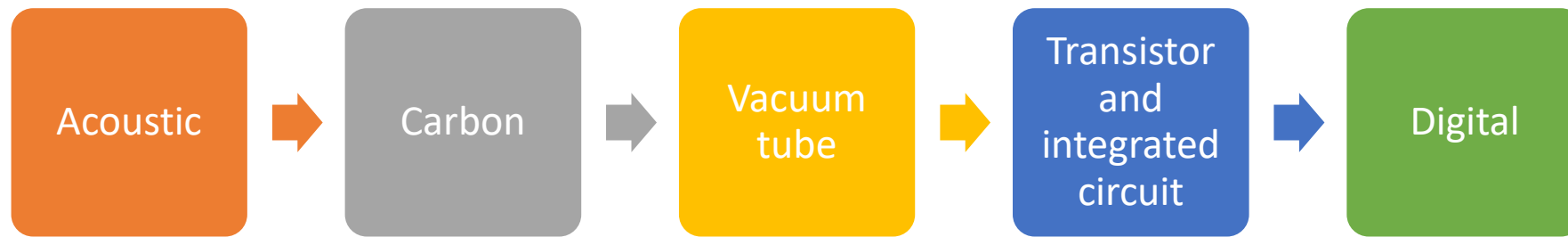


Curran & Glaster (2013). *Trends in Amplification*. 17 May 2013, Fig. 9, p. 10





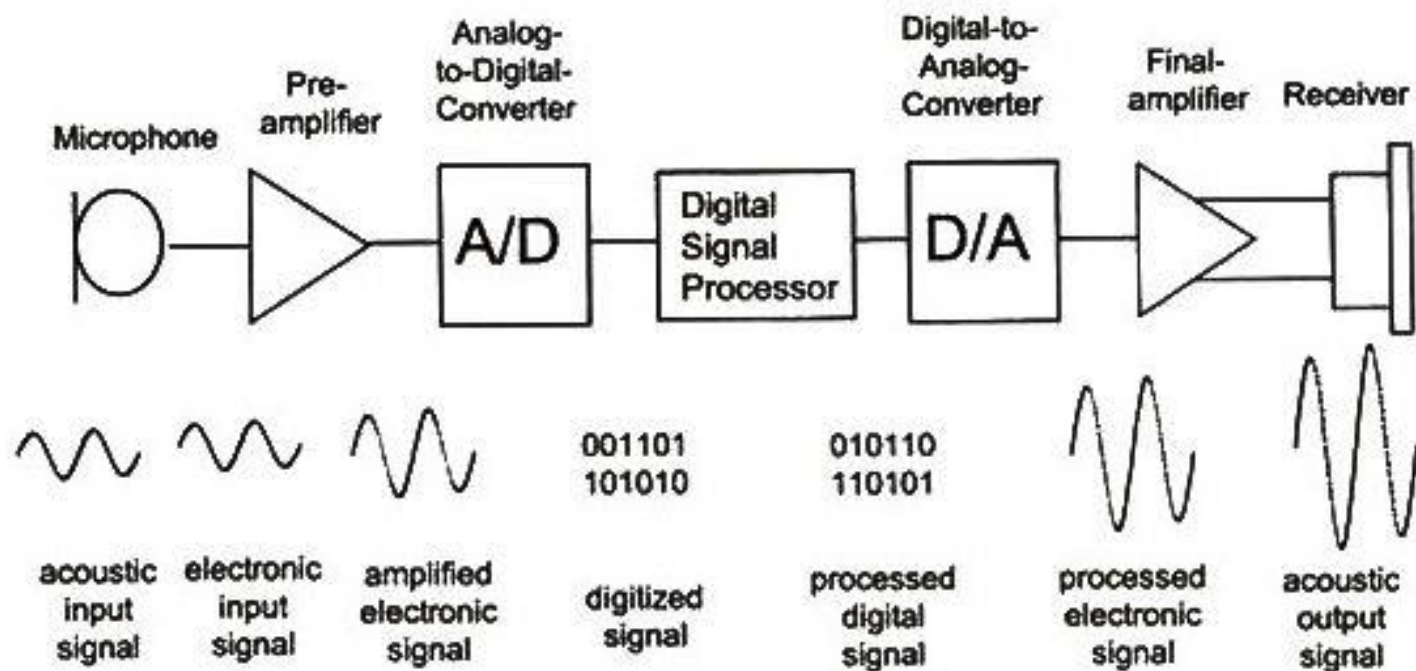
Radioear Model 840 “Lady America” eyeglass hearing aid.





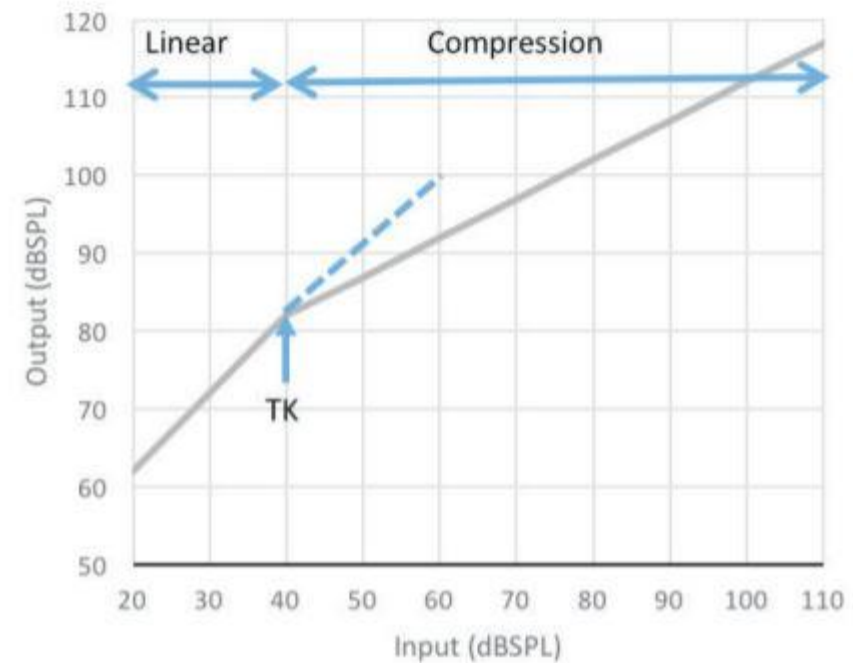
[perfecthearing.my/types-styles-hearing-aids/](https://perfecthearing.my/types-styles-hearing-aids/), Jun 28 2019

# So how do digital hearing aids work?

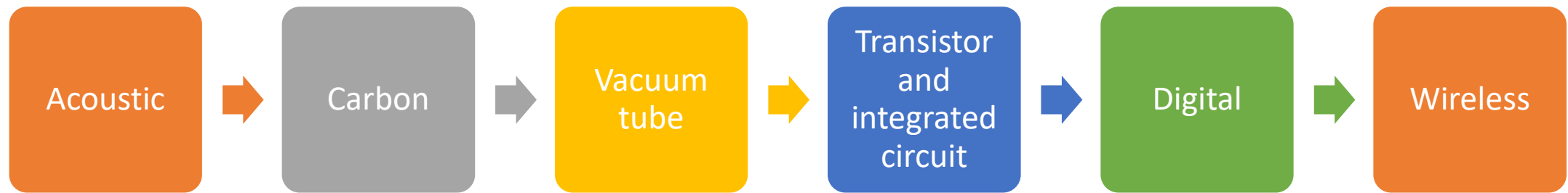


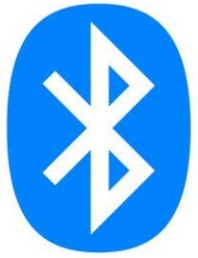
# Digital signal processing (DSP)

- Wide Dynamic Range Compression
- Microphone directionality
- Noise reduction
- Feedback cancellation
- Sound classification



The Compression Handbook, 4<sup>th</sup> Edition, Fig. 2.4, p.12





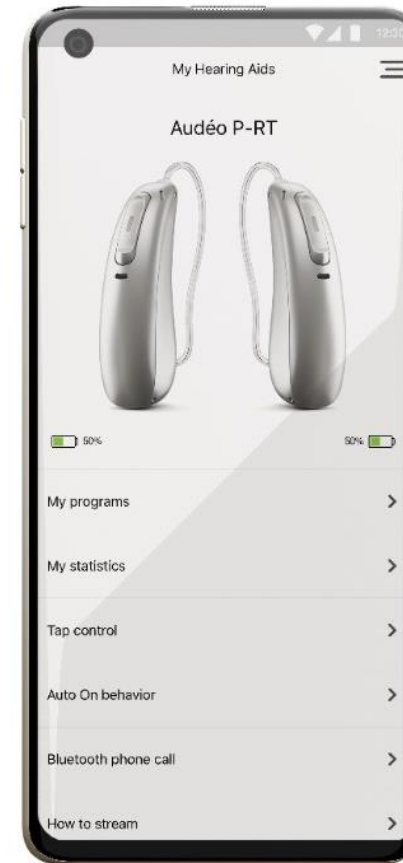
# Wireless

- Enables transmission of signals without degradation caused by noise
- Improves signal-to-noise ratio and eliminates feedback
- Broad applications
  - Microphone and transmitter
  - Coordinated control of bilateral hearing aids
  - Connectivity to communication devices
- Telecare - audiologists can adjust hearing aids remotely



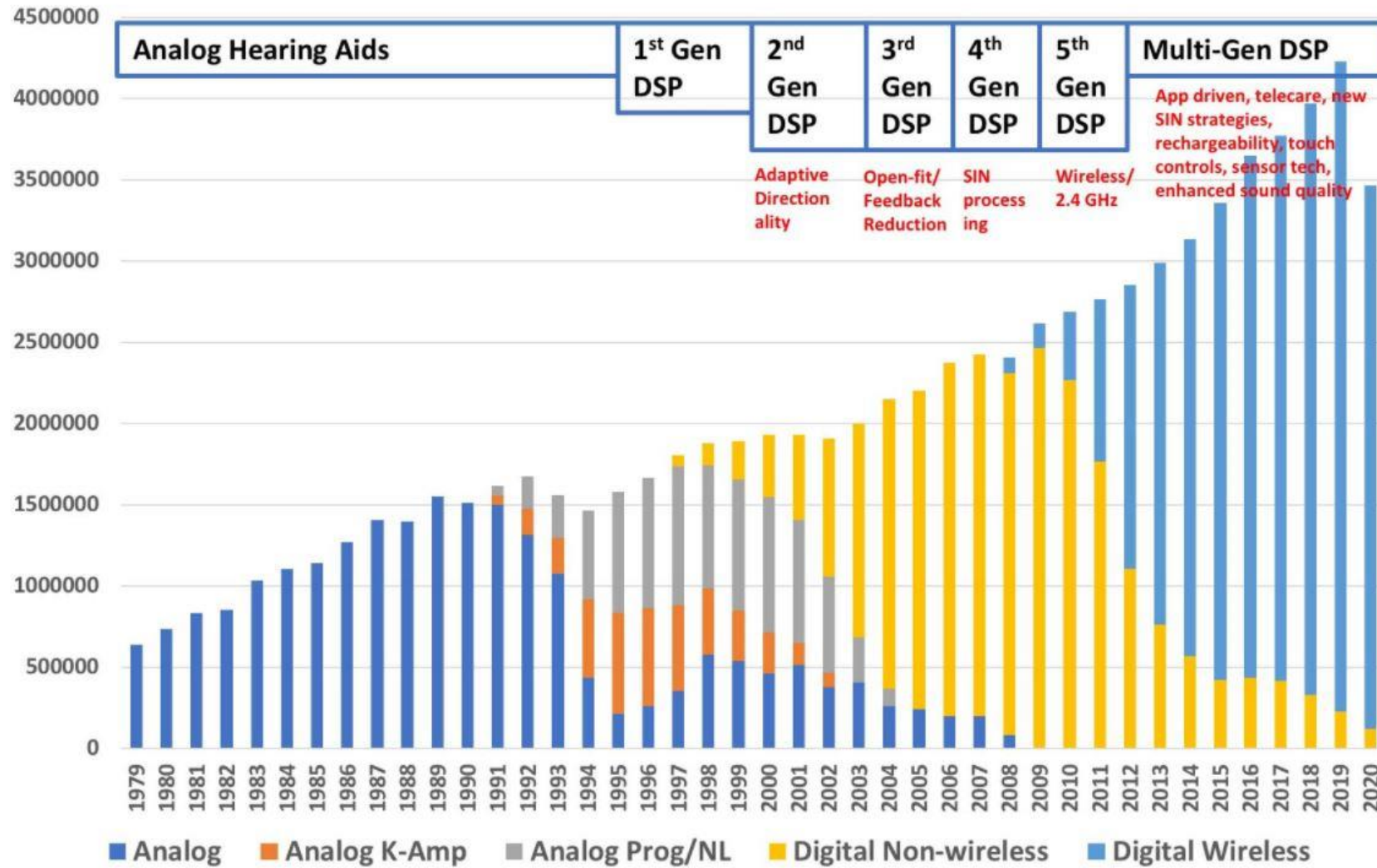
# Phone applications and personalisation

- Can control basic function of hearing aids
- Turn on/off, mute
- Adjust program
- Adjust equalisation (e.g. low, mid, high frequencies) and directional focus





## Hearing Aid Technologies



# Machine learning – Deep Neural Network

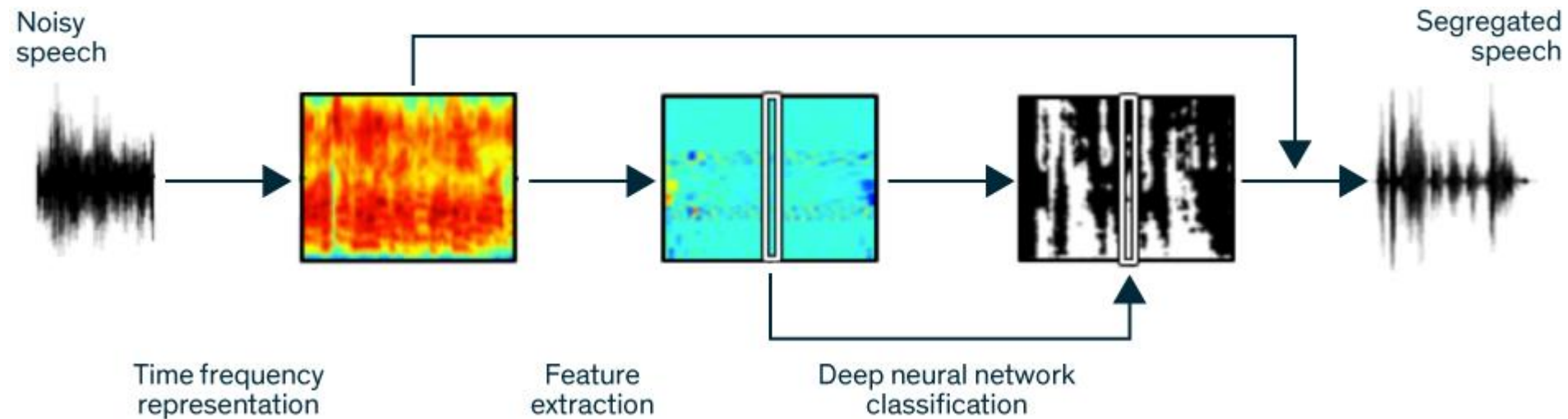
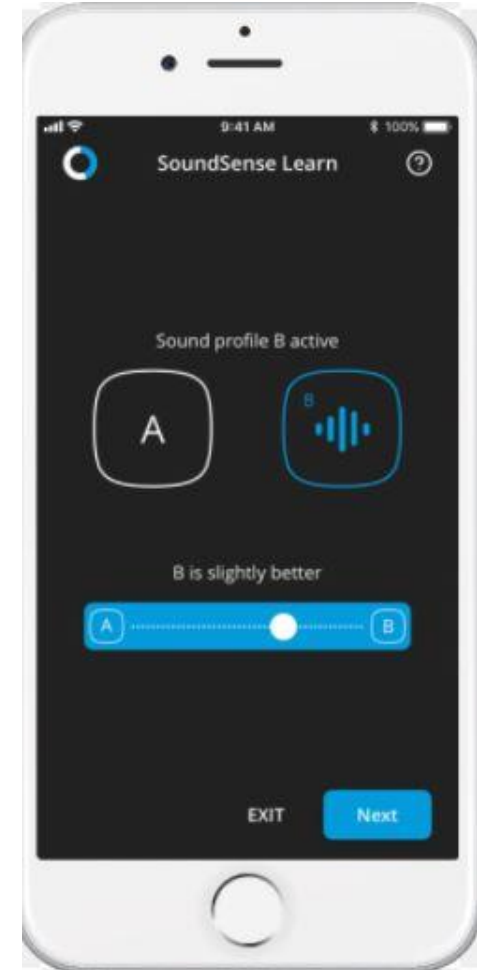


Illustration: Erik Vrielink  
<https://spectrum.ieee.org/consumer-electronics/audiovideo/deep-learning-reinvents-the-hearing-aid>

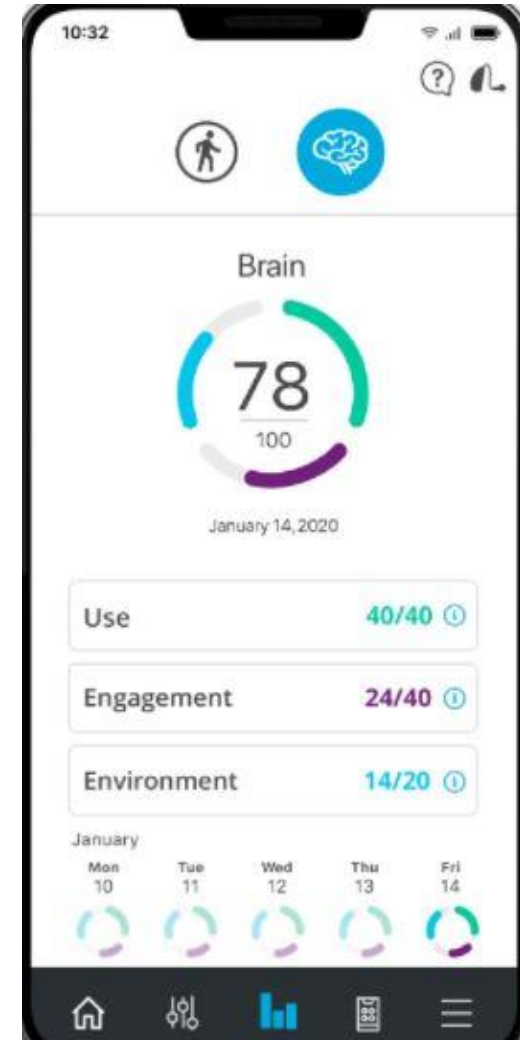
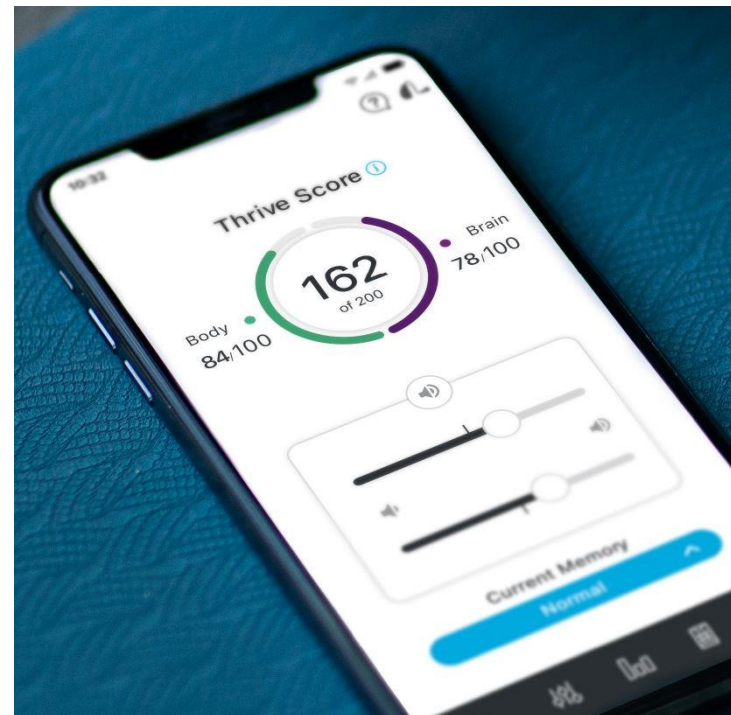
# Machine learning - optimisation

- HA can *learn* user preferences
- HA can remember settings applied in different contexts (incl. use of GPS)
- Paired comparisons – to enhance optimisation
- HA manufacturer build up bigger datasets that can benefit HA users globally
  - i.e. match listening scenarios with preferred settings



# AI – ‘healthable’ hearing aid

- AI-powered speech enhancement
- Activity tracking
- Hearing aid usage log
- Fall detection and alert
- Language translation



# Concluding remarks

- Hearing loss – personal, societal and economic impact
  - Important to intervene early
- HAs have advanced a long way and can help enormously!
  - Digital signal processing, wireless connectivity
- Possibilities afforded by artificial intelligence
  - Sound classification, personalisation, clinical practice



Thank you for listening!

Any questions?

Pop them in the chat for the Q&A.



@musicndeafness