CCD 2026

Hearing and dementia

From ears to brain

Jason Warren

Brain Behaviour Group
Dementia Research Centre, UCL Institute of Neurology
Cognitive Disorders Clinic, National Hospital for Neurology and Neurosurgery
Queen Square, London, United Kingdom

Setting the scene

- Lancet Commission (2017, 2020, 2024) on dementia prevention, intervention and care has identified **midlife hearing loss** as a (the) leading modifiable **risk factor** for dementia onset

- Untreated hearing loss **exacerbates cognitive decline** – wearing hearing aids may help maintain cognitive function

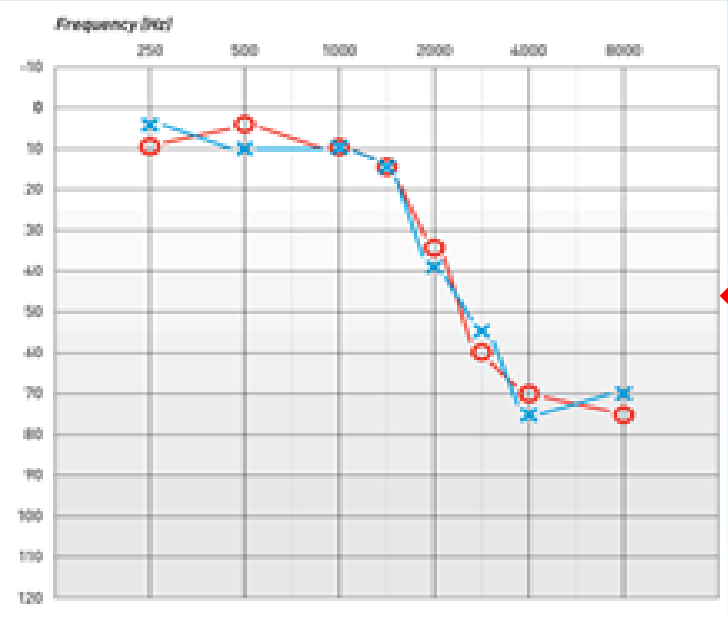
- Evidence that hearing loss directly **causes** dementia (or that hearing aids prevent it) remains very **limited**

- **Limitations** include inadequate definitions of hearing loss and /or dementia, limited follow up periods, lack of biomarker correlation (**Alzheimer's ≠ dementia ≠ cognitive decline / brain atrophy**)

- The association between hearing impairment and dementia is likely **complex and multifactorial**

A core (false) dichotomy

Pure tone audiometry

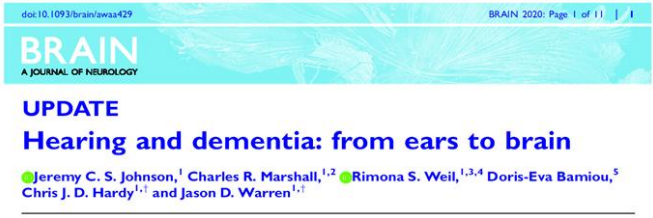


Cochlea function

Real world listening



Brain hearing functions


doi:10.1093/brain/awaa429 BRAIN 2020: Page 1 of 11
BRAIN
A JOURNAL OF NEUROLOGY

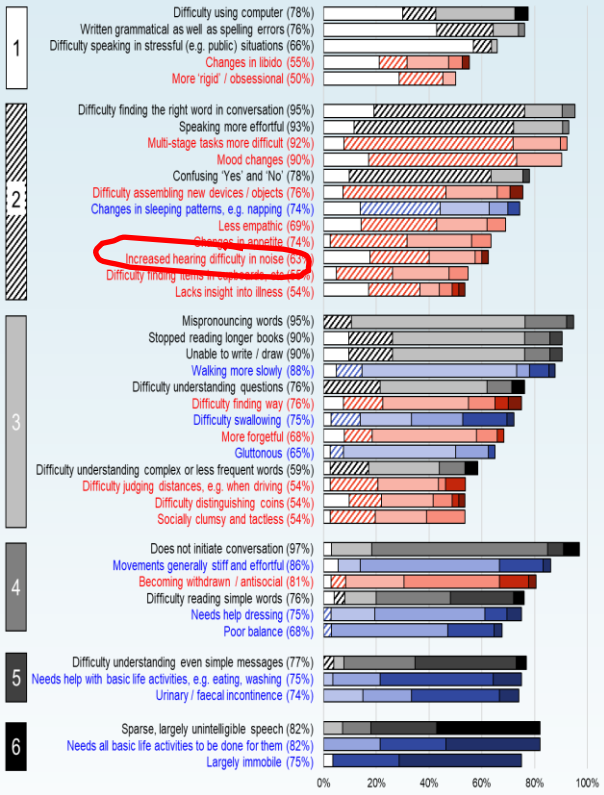
UPDATE

Hearing and dementia: from ears to brain

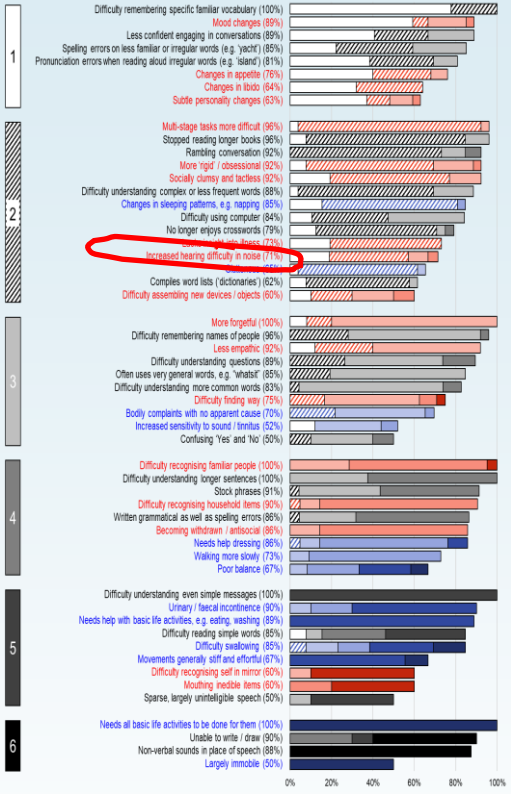
Jeremy C. S. Johnson,[1] Charles R. Marshall,[1,2] Rimona S. Weil,[1,3,4] Doris-Eva Bamiou,[5] Chris J. D. Hardy[1,†] and Jason D. Warren[1,†]

Hearing changes occur early in PPA syndromes

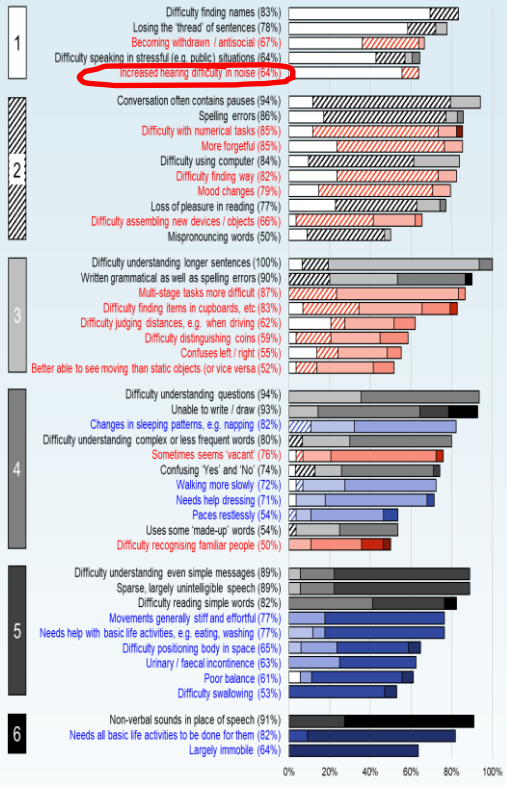
nfvPPA



svPPA



lvPPA



DOI: 10.1002/alz.13415

RESEARCH ARTICLE

Alzheimer's & Dementia®
THE JOURNAL OF THE ALZHEIMER'S ASSOCIATION

Symptom-led staging for semantic and non-fluent/agrammatic variants of primary progressive aphasia

Chris J. D. Hardy[1] | Cathleen Taylor-Rubin[2,3] | Beatrice Taylor[4] | Emma Harding[1] | Aida Suarez Gonzalez[1] | Jessica Jiang[1] | Laura Thompson[2] | Rachel Kingma[2] | Anthipa Chokesuwattanaskul[1,5,6] | Ffion Walker[7] | Suzie Barker[1] | Emilie Brotherhood[1] | Claire Waddington[1] | Olivia Wood[1] | Nikki Zimmermann[1] | Nuriye Kupeli[8] | Keir X. X. Yong[1] | Paul M. Camic[1] | Joshua Stott[1,9] | Charles R. Marshall[10] | Neil P. Oxtoby[4] | Jonathan D. Rohrer[1] | Anna Volkmer[1,11] | Sebastian J. Crutch[1] | Jason D. Warren[1]

DOI: 10.1111/ene.16304

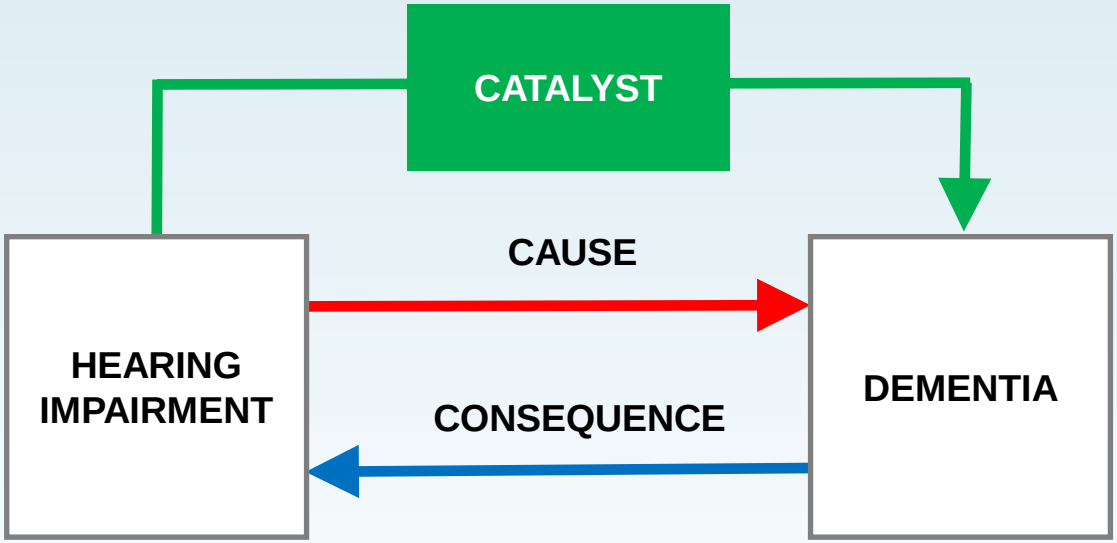
ORIGINAL ARTICLE

european journal of neurology

Symptom-based staging for logopenic variant primary progressive aphasia

Chris J. D. Hardy[1] | Cathleen Taylor-Rubin[2,3] | Beatrice Taylor[4] | Emma Harding[1] | Aida Suarez Gonzalez[1] | Jessica Jiang[1] | Laura Thompson[2] | Rachel Kingma[2] | Anthipa Chokesuwattanaskul[1,5,6] | Ffion Walker[7] | Suzie Barker[1] | Emilie Brotherhood[1] | Claire Waddington[1] | Olivia Wood[1] | Nikki Zimmermann[1] | Nuriye Kupeli[8] | Keir X. X. Yong[1] | Paul M. Camic[1] | Joshua Stott[1,9] | Charles R. Marshall[10] | Neil P. Oxtoby[4] | Jonathan D. Rohrer[1] | Frankie O'Shea[1] | Anna Volkmer[11] | Sebastian J. Crutch[1] | Jason D. Warren[1]

A complex linkage…



doi:10.1093/brain/awaa429 BRAIN 2020: Page 1 of 11 | 1

BRAIN
A JOURNAL OF NEUROLOGY

UPDATE

Hearing and dementia: from ears to brain

Jeremy C. S. Johnson,[1] Charles R. Marshall,[1,2] Rimona S. Weil,[1,3,4] Doris-Eva Bamiou,[5] Chris J. D. Hardy[1,†] and Jason D. Warren[1,†]

Journal of Neurology (2025) 272:402
https://doi.org/10.1007/s00415-025-13140-x

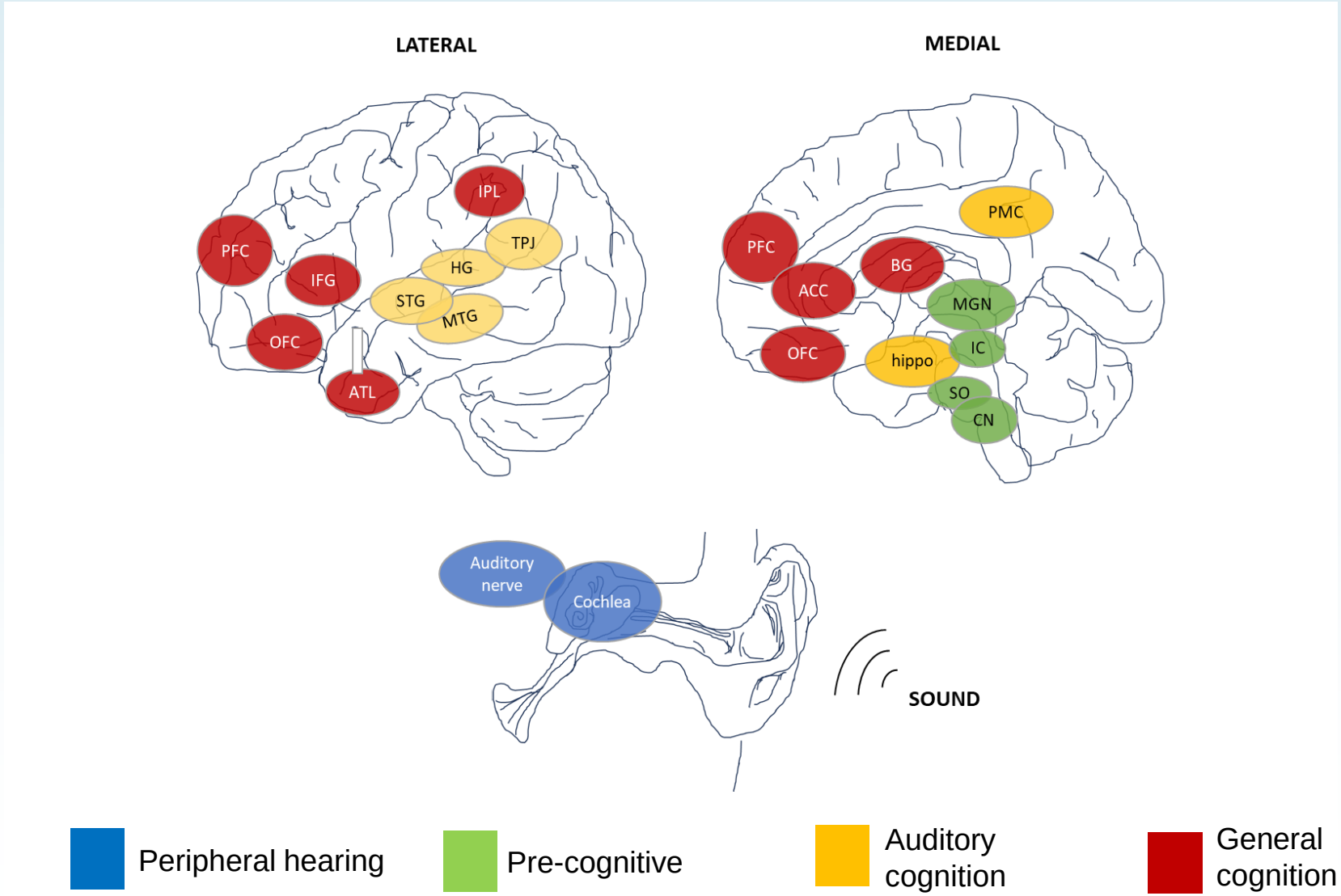
NEUROLOGICAL UPDATE

Hearing impairment and dementia: cause, catalyst or consequence?

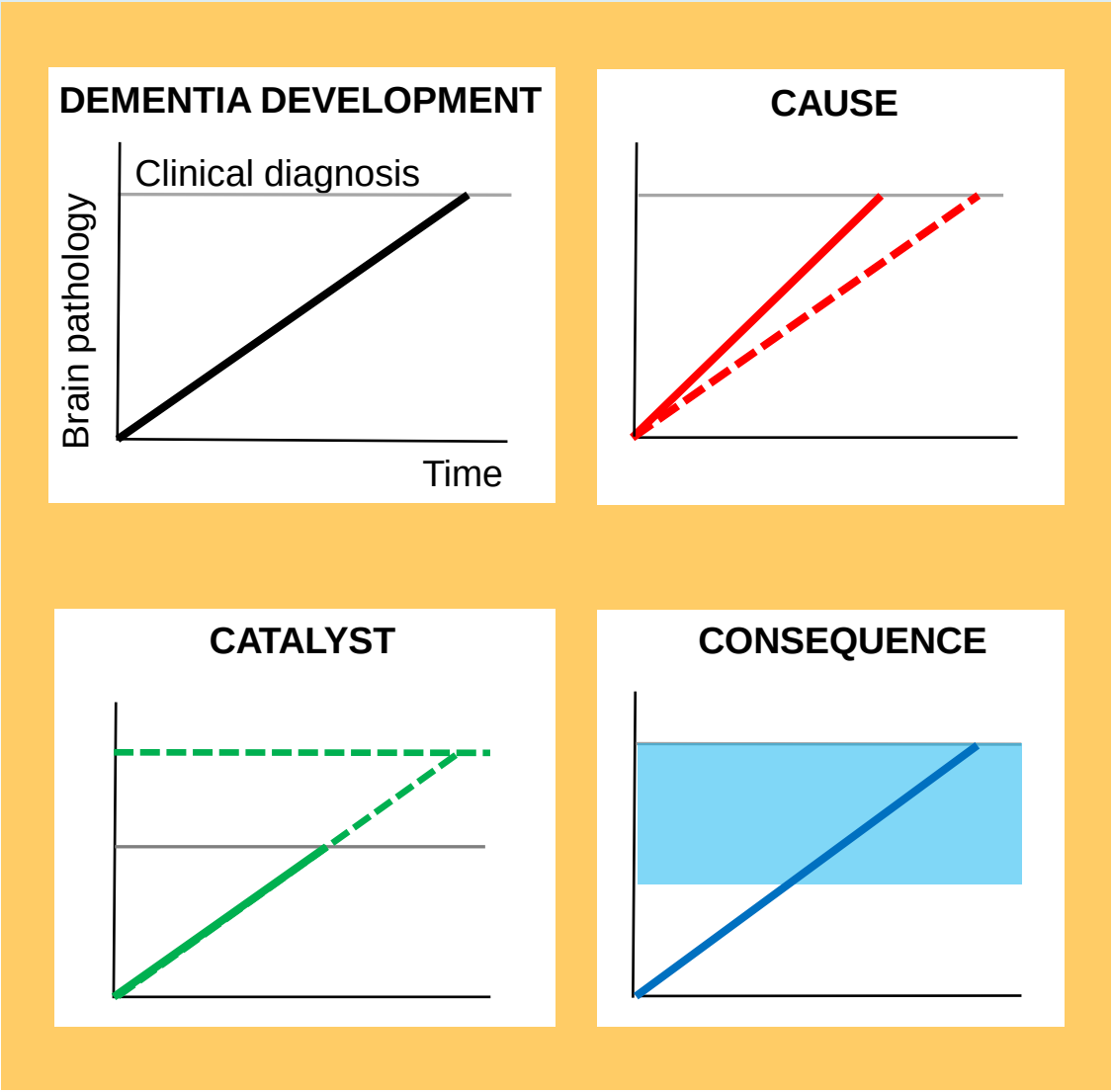
Benjamin A. Levett[1] · Avinash Chandra[2] · Jessica Jiang[1] · Nehzat Koohi[3,4] · Dale Sharrad[5] · Lucy B. Core[1] · Jeremy C. S. Johnson[1,6] · Madison Tutton[7] · Tim Green[7,8] · Dona M. P. Jayakody[9] · Jin-Tai Yu[10] · Iracema Leroi[11,12] · Charles R. Marshall[2] · Doris-Eva Bamiou[5,13] · Chris J. D. Hardy[1] · Jason D. Warren[1]

Brain hearing

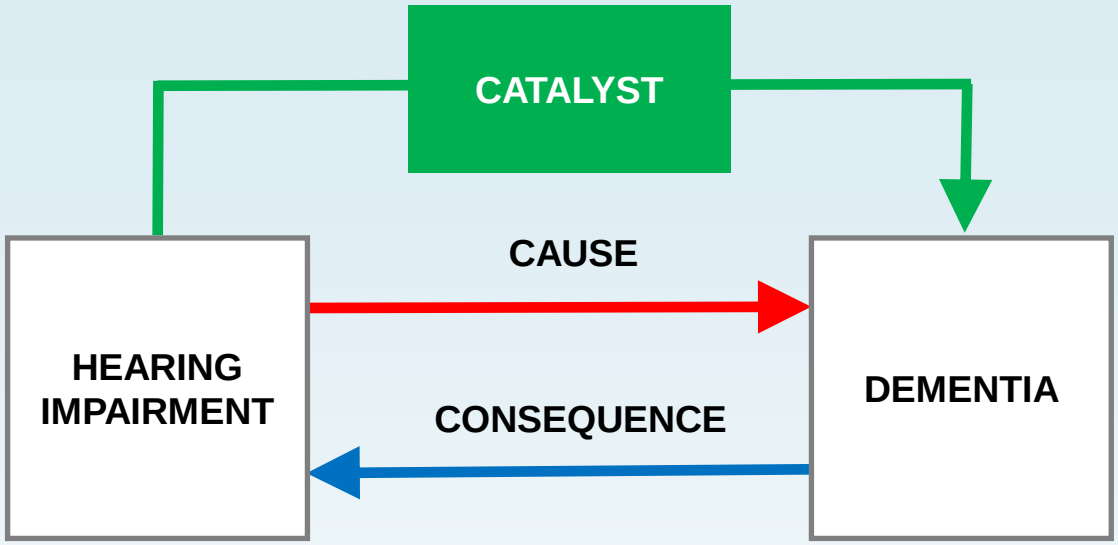
Hearing in complex everyday listening environments depends on brain processes

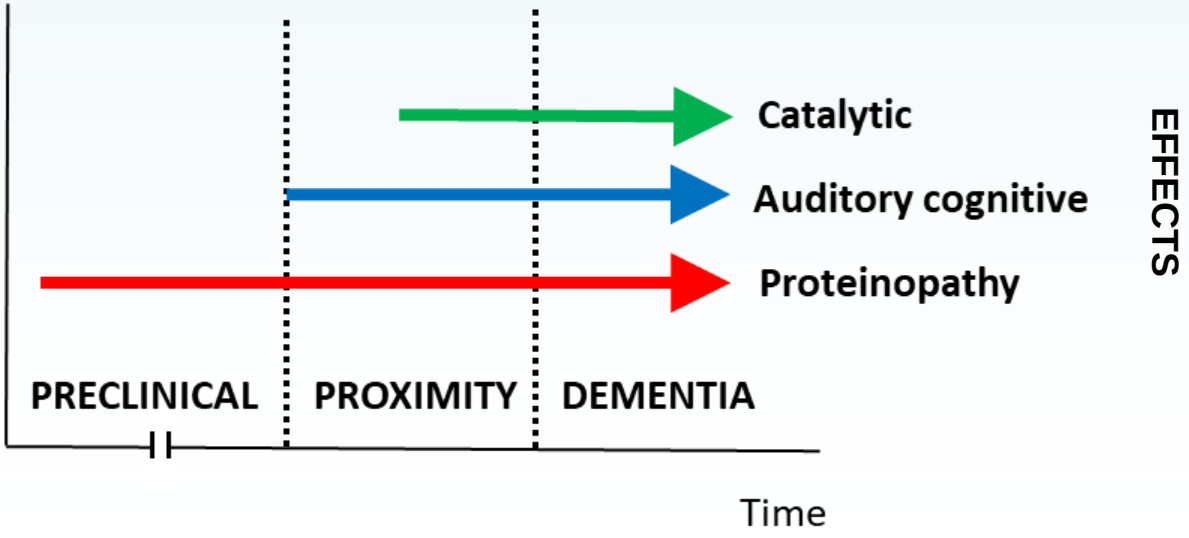


Is hearing loss a cause, catalyst or consequence of dementia?

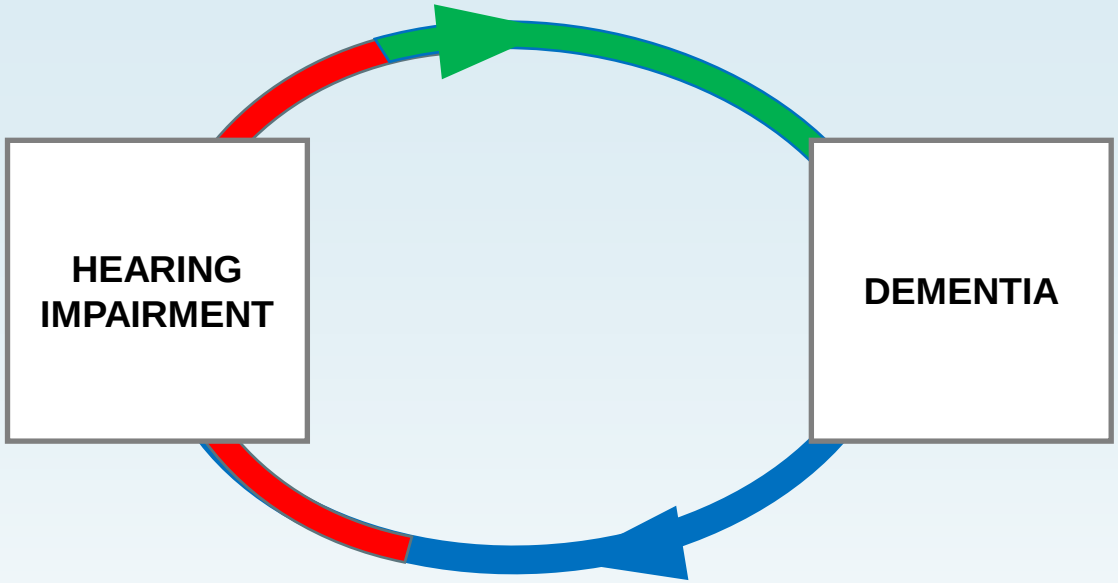


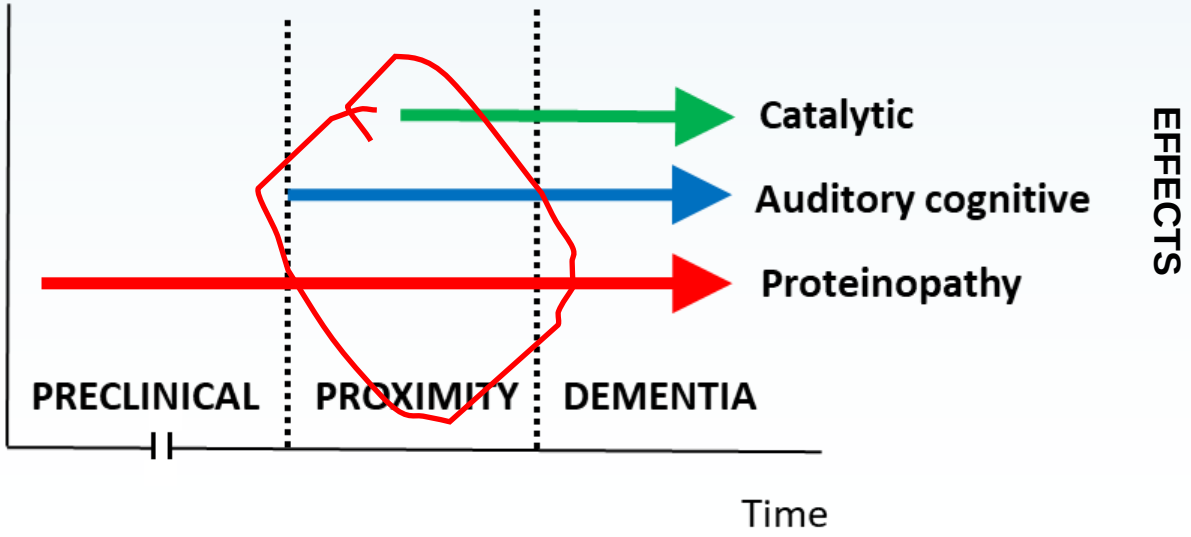
Potential for interaction (and vicious cycles)



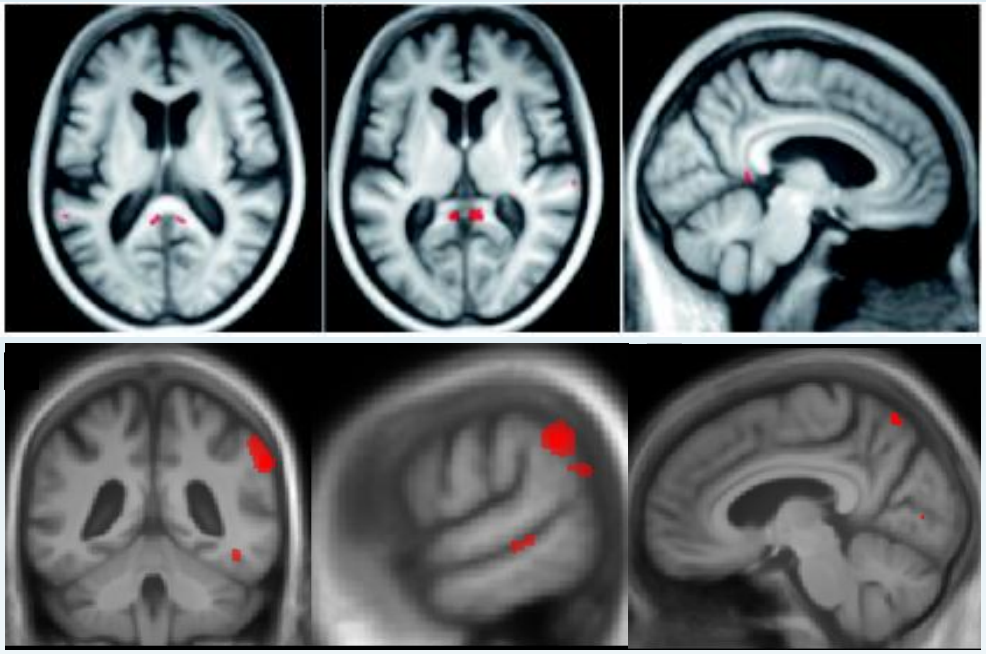


Potential for interaction (and vicious cycles)





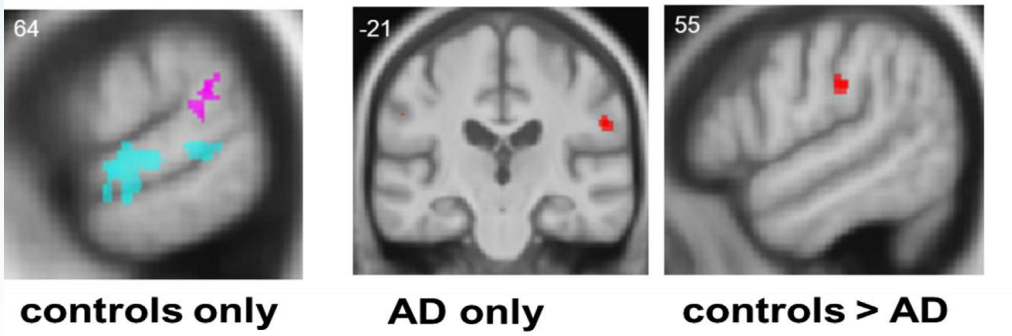
The auditory brain in Alzheimer's



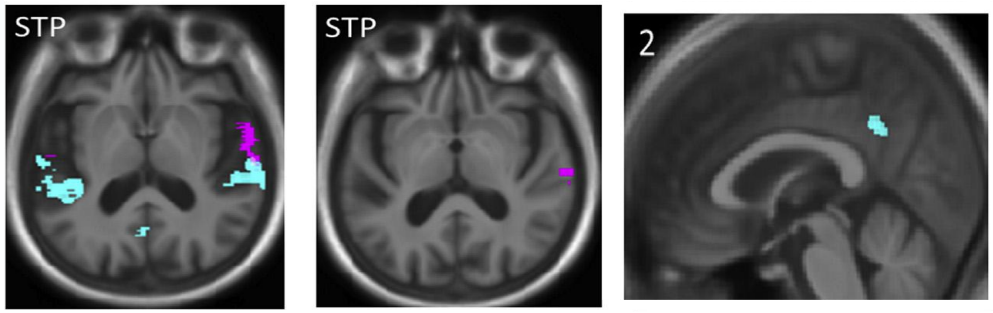
Goll et al., *Brain*, 2011; VBM
Auditory scene analysis in AD



Golden et al., *Brain*, 2014; VBM
Sound motion perception in AD

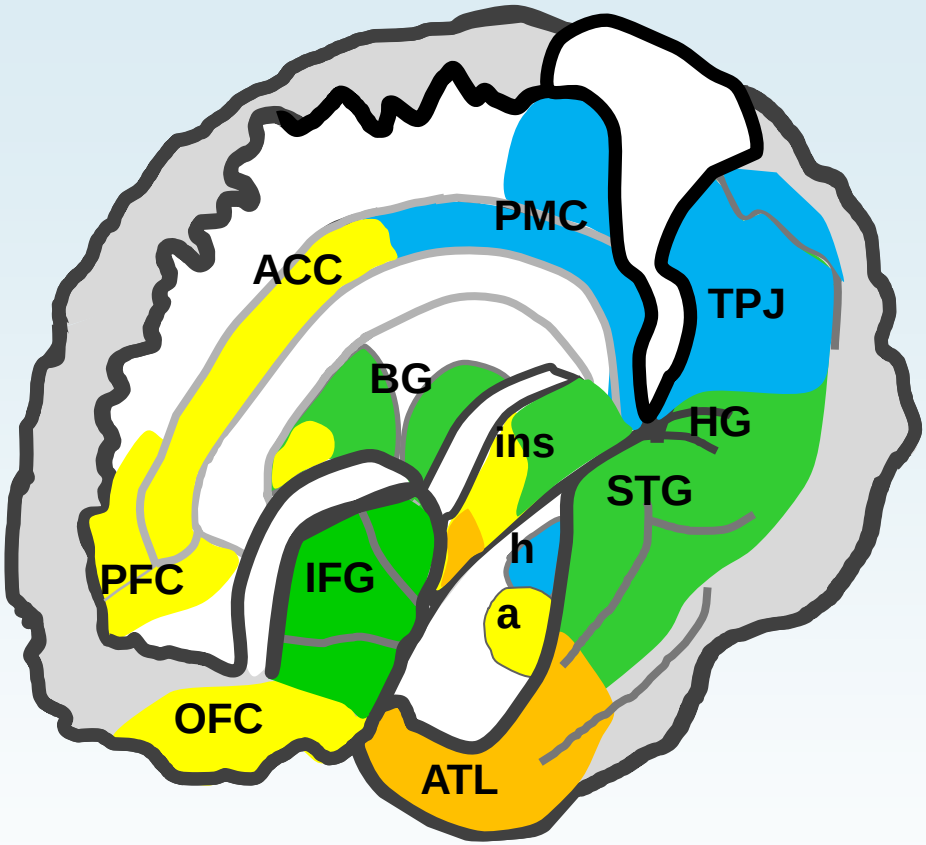


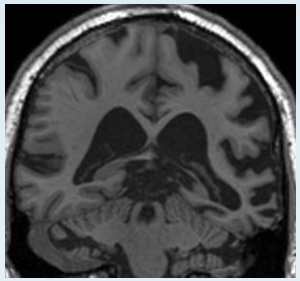
Golden et al., *NI* 2015; fMRI
'Cocktail' party' effect AD v controls



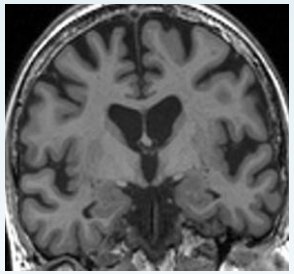
Golden et al., *NBA* 2016; fMRI
Virtual auditory space AD v controls

Dementias have distinctive brain hearing phenotypes

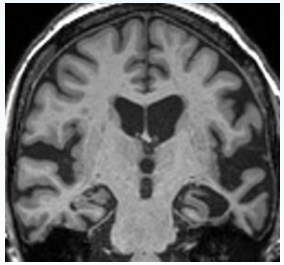




AD / logopenic PPA



Nonfluent PPA



Semantic PPA

scenes

patterns

recognition

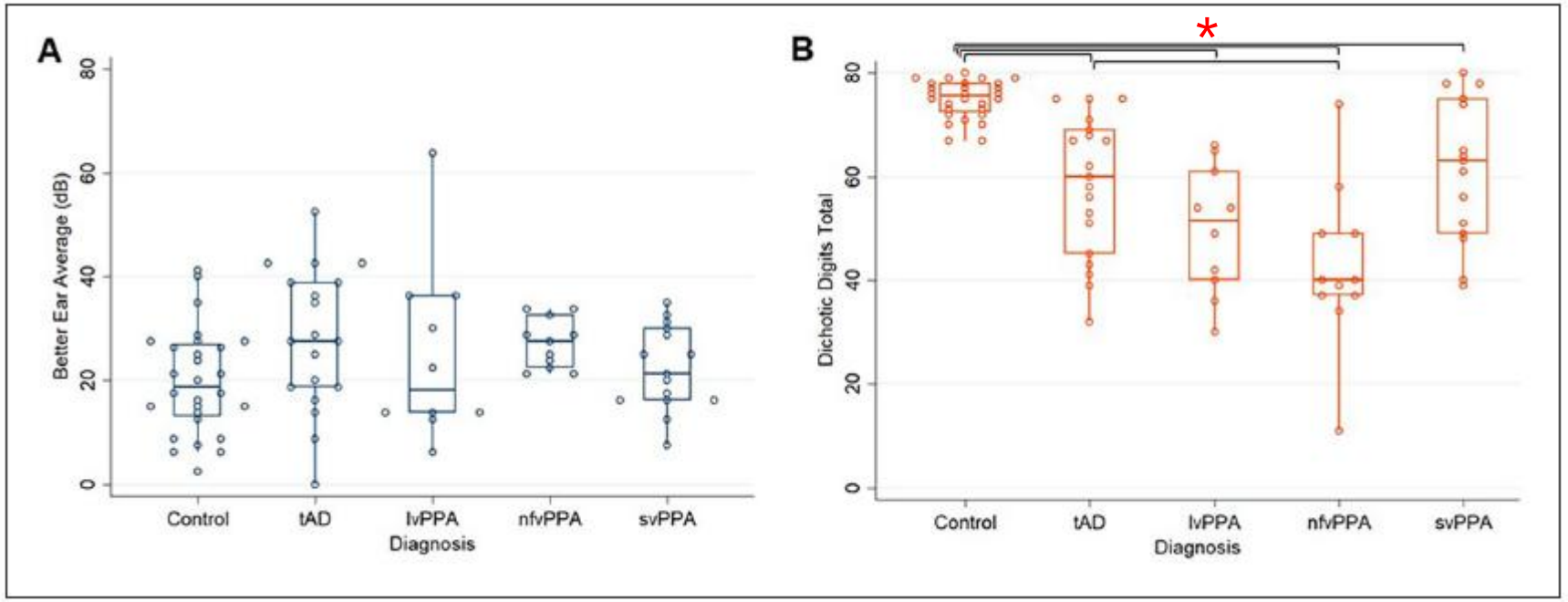
emotion

Queen Square Tests of Auditory Cognition (QSTAC)

Brain hearing tests can dectect dementia

Pure tone audiometry

Dichotic digits test



Special Issue Paper

QJEP

Quarterly Journal of Experimental Psychology
1–19

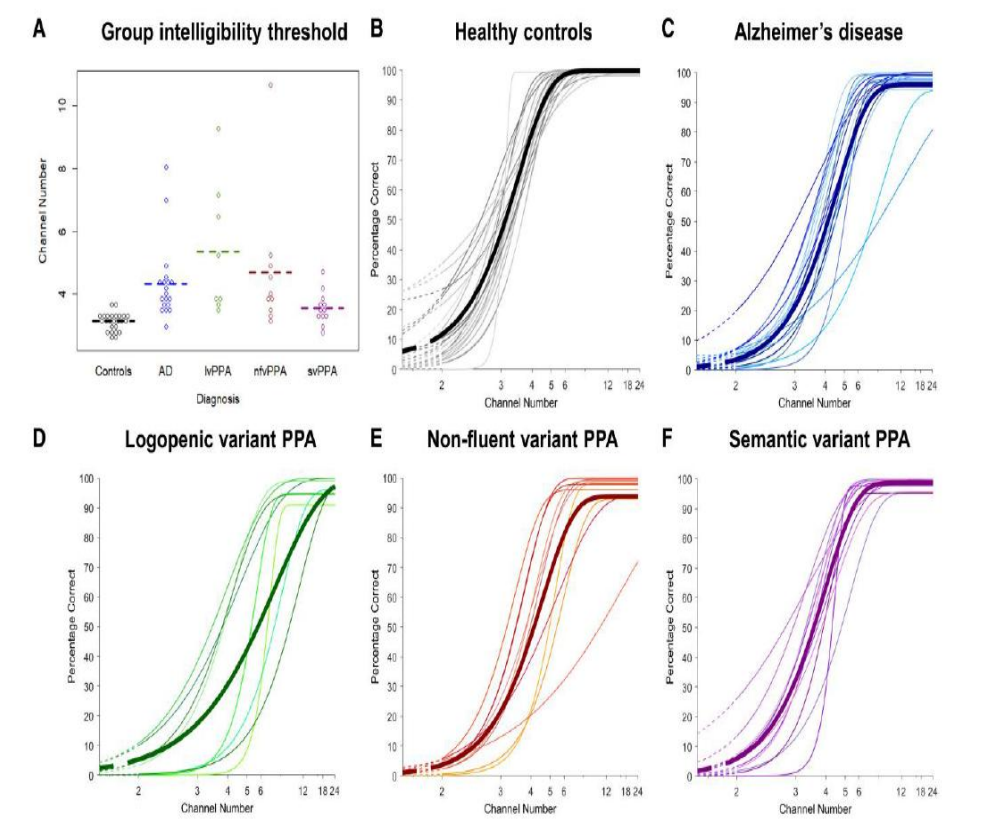
© Experimental Psychology Society 2024
Article reuse guidelines:
sagepub.com/journals-permissions

DOI: 10.1177/17470218241287349
qjep.sagepub.com
Sage

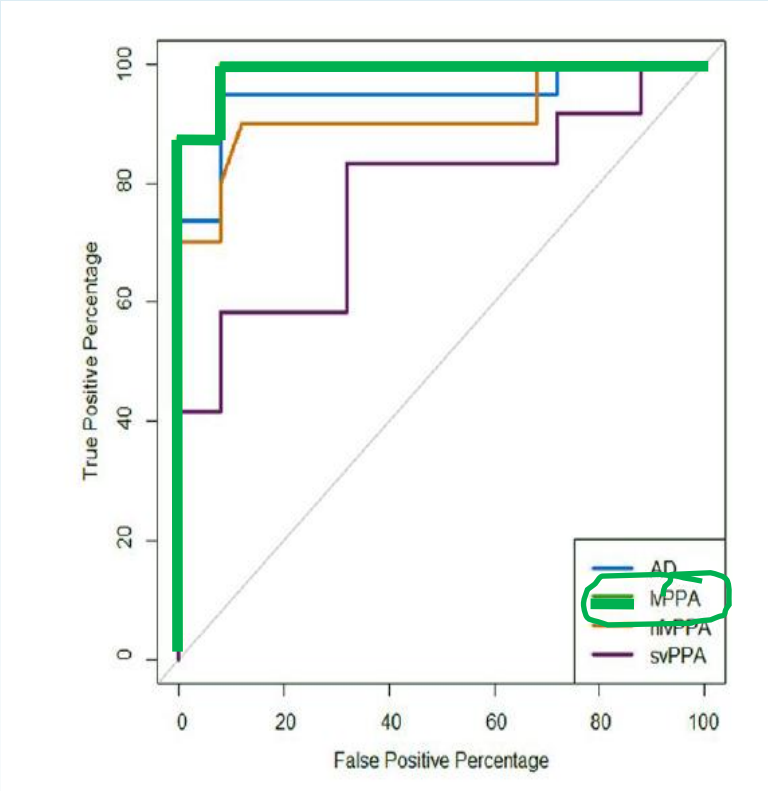
Pure-tone audiometry and dichotic listening in primary progressive aphasia and Alzheimer's disease

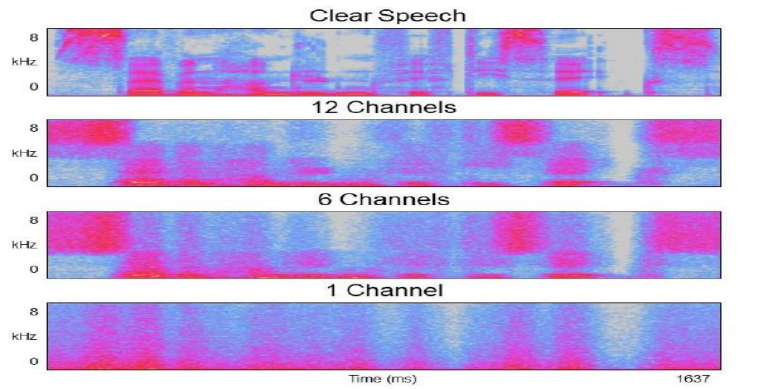
Jessica Jiang[1,*], Jeremy Johnson[1,2,*], Benjamin A Levett[1], Lucy B Core[1], Anna Volkmer[3], Nehzat Koohi[4,5], Doris-Eva Bamiou[5], Charles R Marshall[6], Jason D Warren[1,†] and Chris JD Hardy[1,†]

Brain hearing tests can detect dementia



ROC analysis vs healthy controls



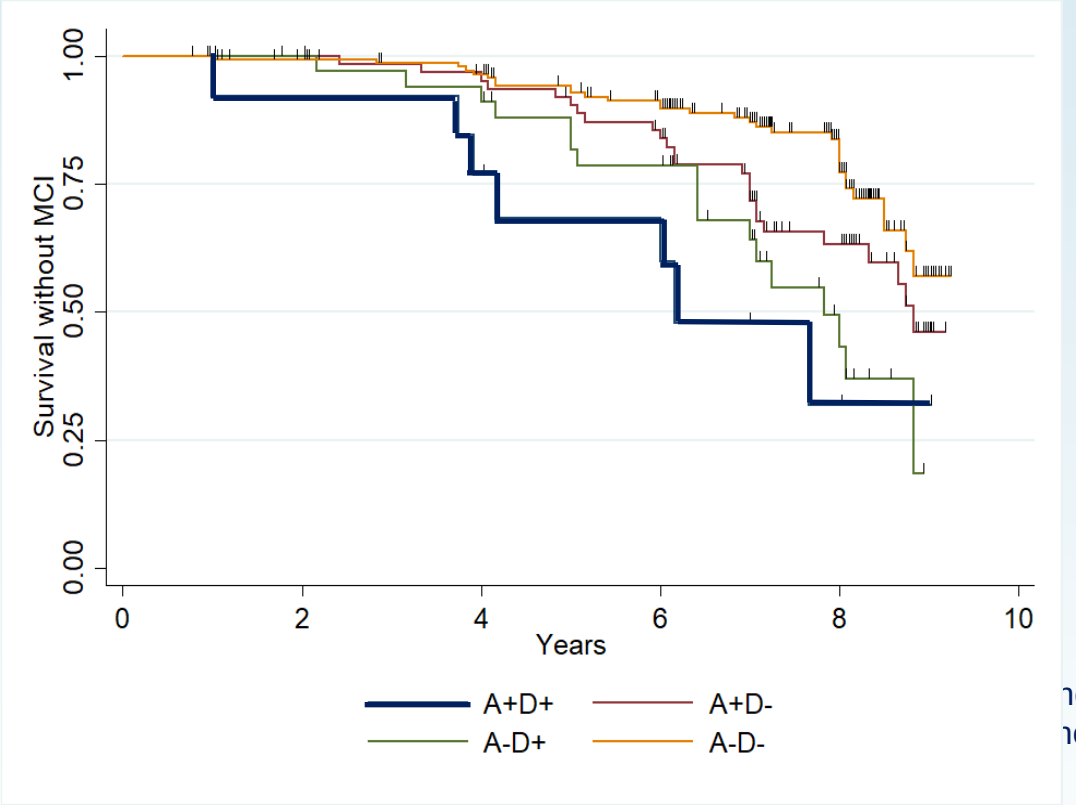


https://doi.org/10.1093/brain/awad163 BRAIN 2023: 00; 1–12 | 1
BRAIN
ORIGINAL ARTICLE

Comprehension of acoustically degraded speech in Alzheimer's disease and primary progressive aphasia

Jessica Jiang,[1] Jeremy C. S. Johnson,[1] Maï-Carmen Requena-Komuro,[1,2] Elia Benhamou,[1] Harri Sivasathiaseelan,[1] Anthipa Chokesuwattanaskul,[1,3] Annabel Nelson,[1] Ross Nortley,[1,4] Rimona S. Weil,[1] Anna Volkmer,[5] Charles R. Marshall,[6] Doris-Eva Bamiou,[7] Jason D. Warren[1,†] and Chris J. D. Hardy[1,†]

Brain hearing tests can predict dementia



Hardy et al., *unpublished*

heimer markers
notic listening performance

Received: 25 March 2025 | Revised: 27 June 2025 | Accepted: 23 July 2025
DOI: 10.1002/alz.70653

PERSPECTIVE

Alzheimer's & Dementia
THE JOURNAL OF THE ALZHEIMER'S ASSOCIATION

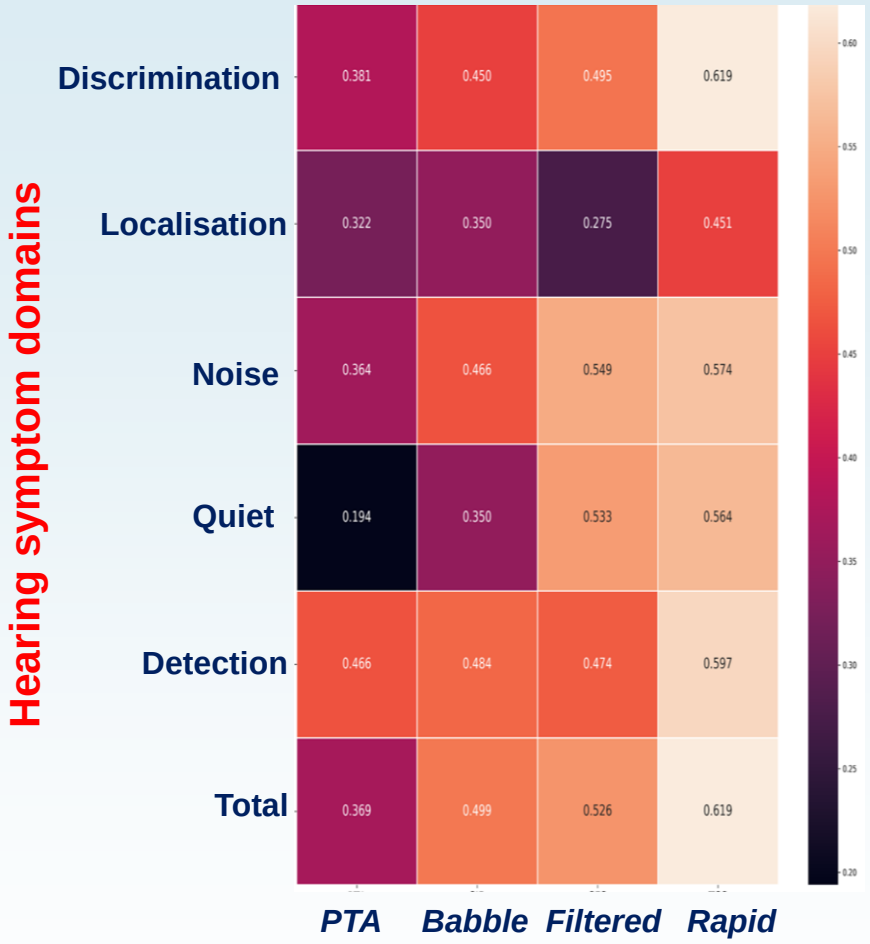
The PREVENT-AD cohort: Accelerating Alzheimer's disease research and treatment in Canada and beyond

Research Article

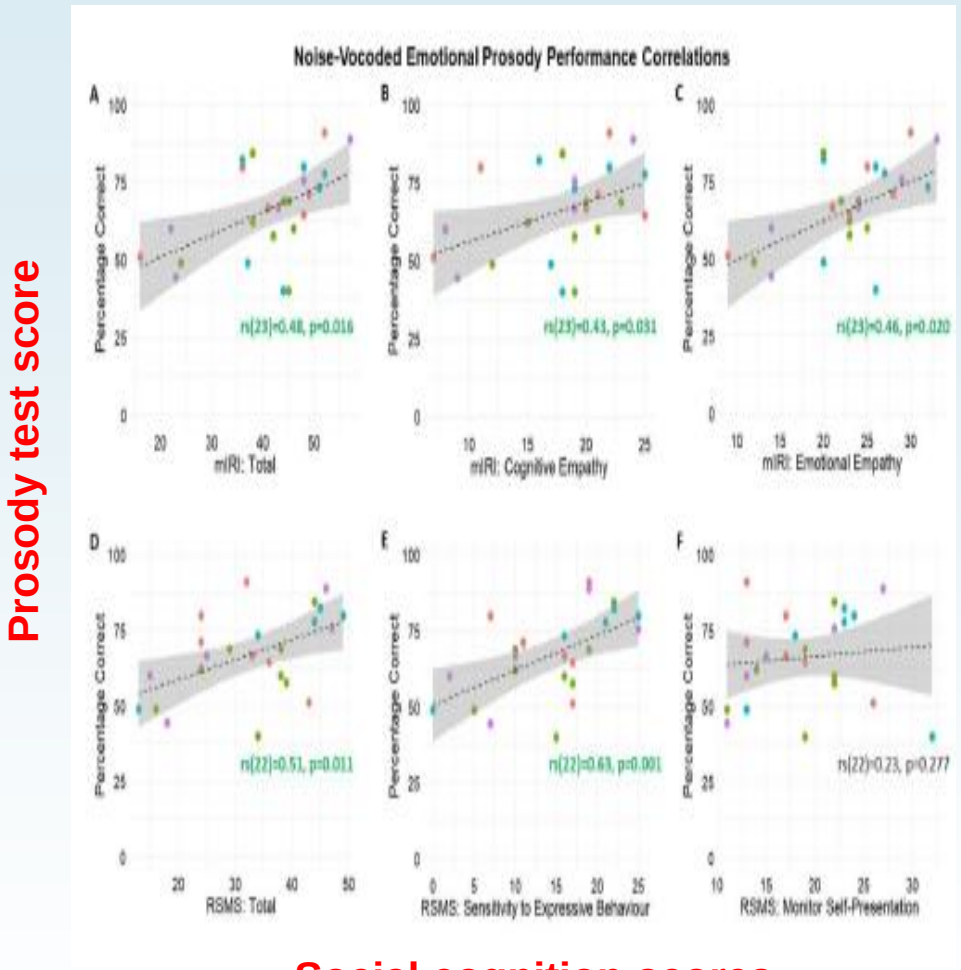
Deficit in Central Auditory Processing as a Biomarker of Pre-Clinical Alzheimer's Disease

Miranda Tuwaig[a,b], Mélissa Savard[a], Benoît Jutras[c,d], Judes Poirier[a,b], D. Louis Collins[a,b], Pedro Rosa-Neto[a,b], David Fontaine[a], and John C.S. Breitner[a,b,*] for the PREVENT-AD Research Group[a,b]

Brain hearing tests can predict daily life functioning



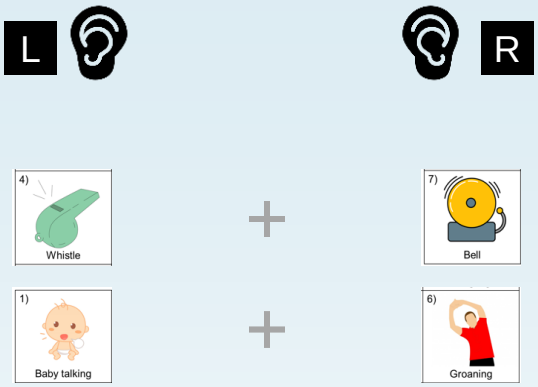
Degraded speech perception in PPA
Johnson *et al., Neurology* 2025



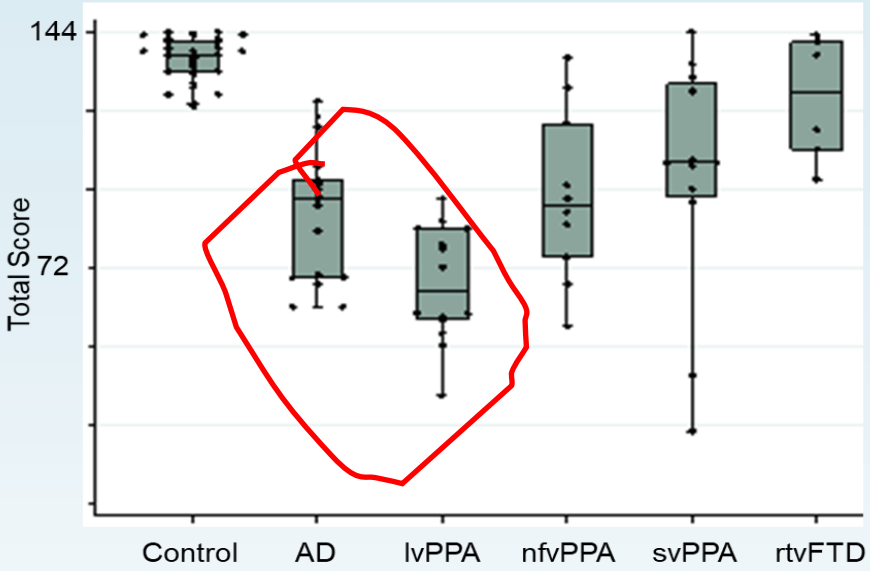
Degraded prosody perception in PPA
Jiang *et al., Sci Rep* 2024

Brain hearing tests for inclusive dementia detection

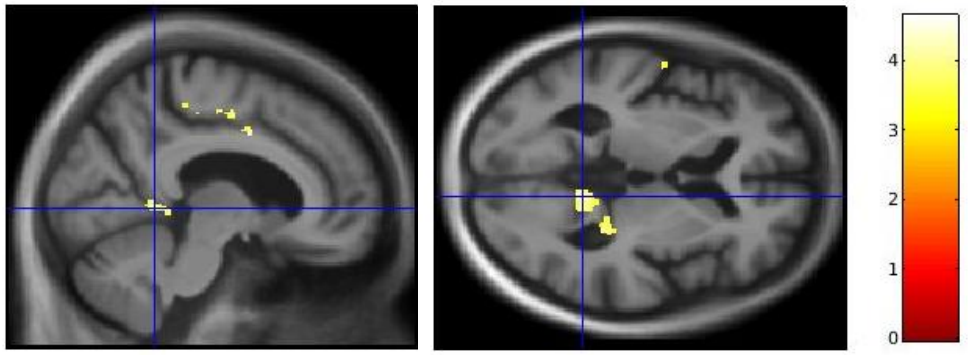
Nonverbal dichotic listening



Syndromic group scores



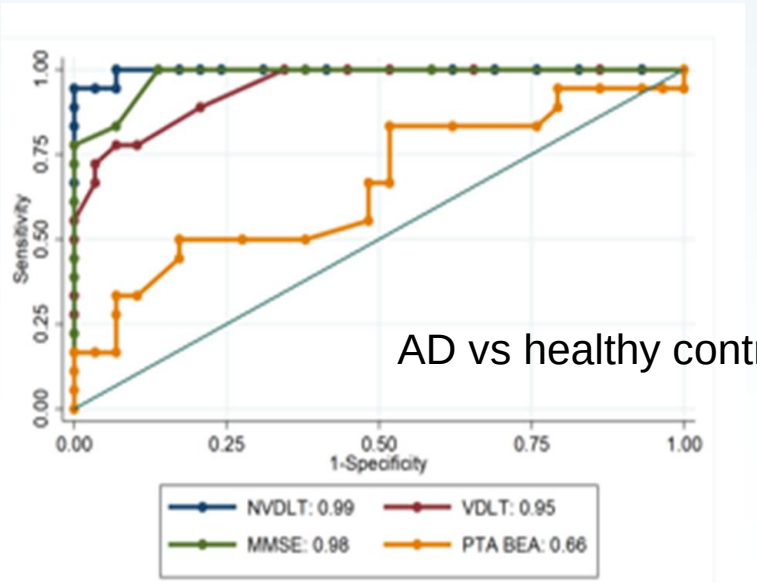
VBM correlate



DOI: 10.1002/alz.71358
SHORT REPORT
Alzheimer's & Dementia
THE JOURNAL OF THE ALZHEIMER'S ASSOCIATION

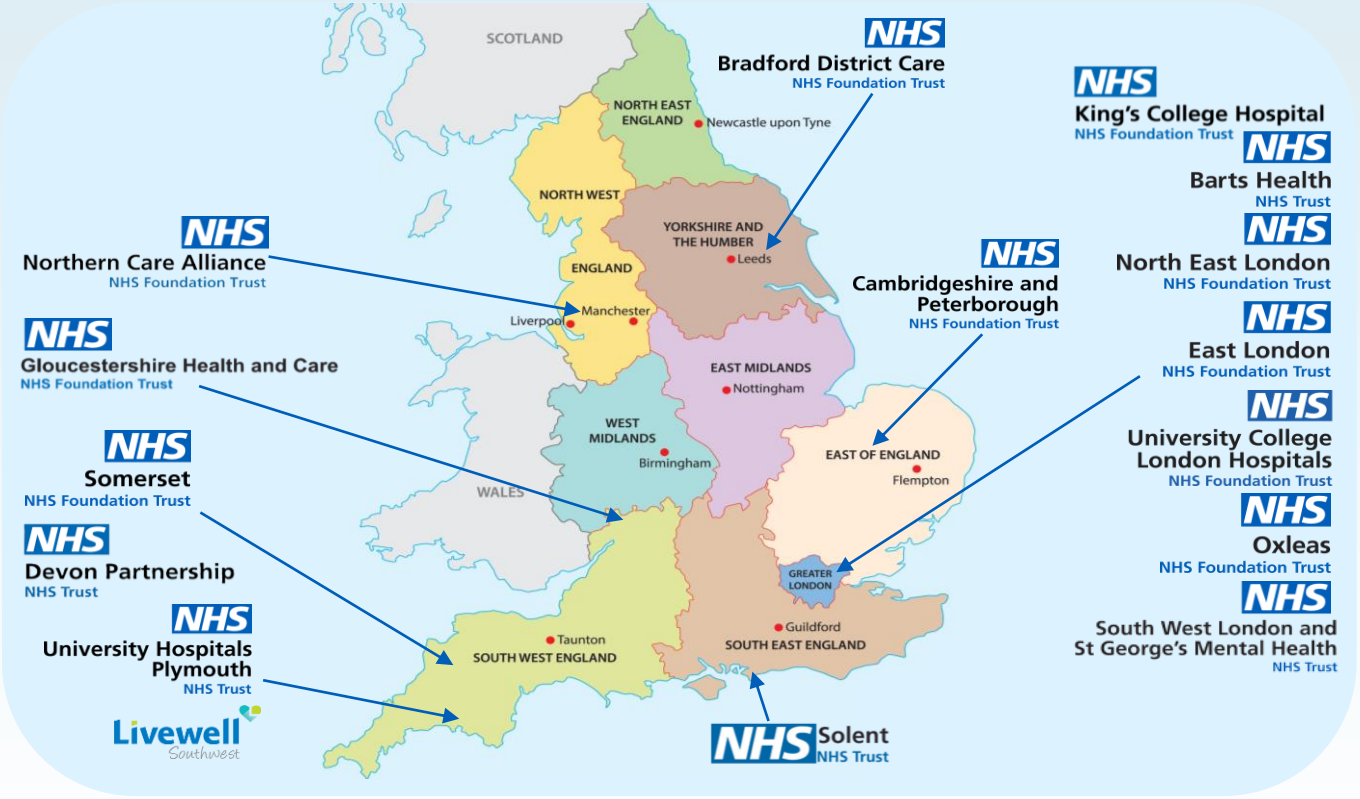
Non-verbal dichotic listening: A new cognitive hearing test for dementia

Chris J. D. Hardy[1] | Benjamin A. Levett[1] | Jessica Jiang[1] | Lucy B. Core[1] | Sophie Froud[1] | Lauren Bishop[1,2] | Dicky Lim[2] | Faiza Durrani[2] | Anna Volkmer[3] | Nehzat Koohi[4,5] | Doris-Eva Bamiou[4,5] | Charles R. Marshall[2] | Jason D. Warren[1]



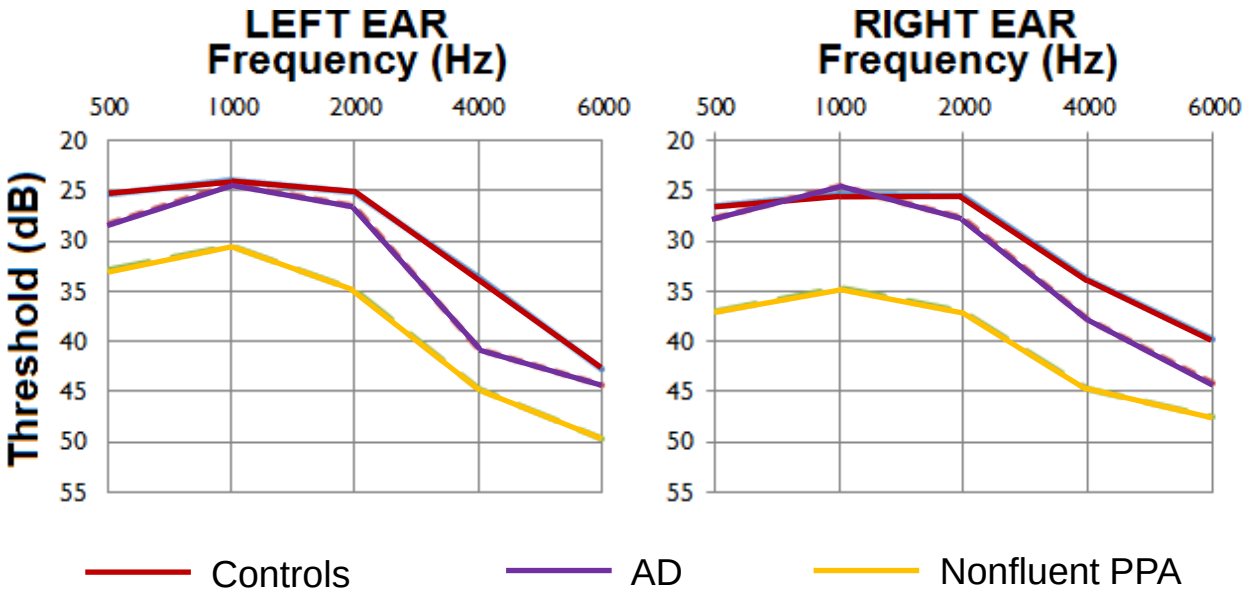
AD vs healthy controls

Digital Assessment of Auditory Perception in Dementia (DiADem)



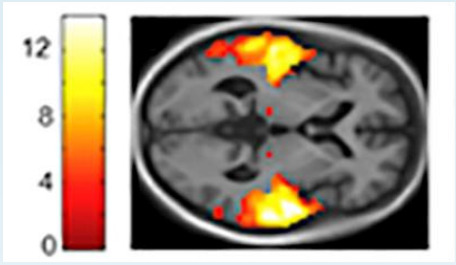
Led jointly from UCL and Queen Mary University of London
470 memory clinic attendees, brain hearing + audiometry + general cog tests, plasma ptau217
Baseline, year 1 + year 2 follow-up

A (further) caveat on interpreting pure tone audiometry

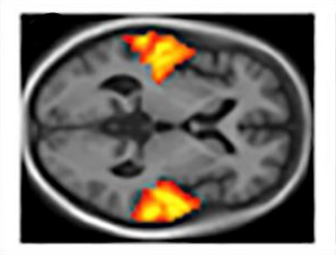


fMRI sound > silence

Controls



nfvPPA



Controls > nfvPPA



JAMA Neurology | Brief Report

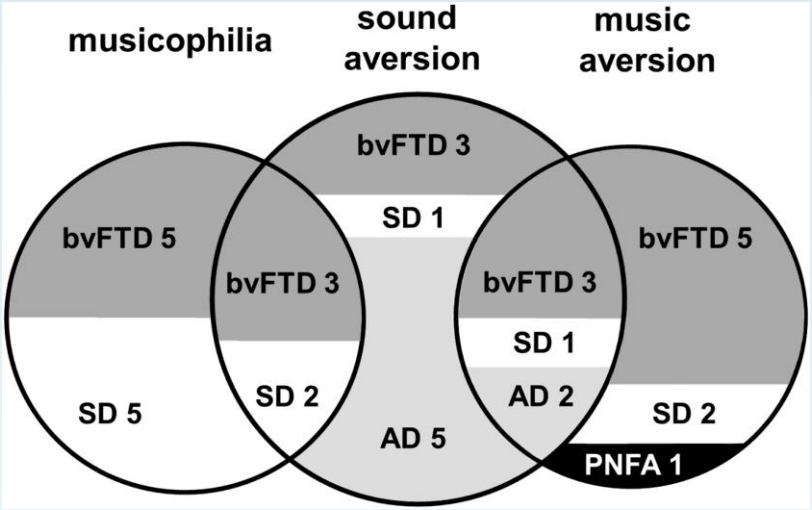
Findings of Impaired Hearing in Patients With Nonfluent/Agrammatic Variant Primary Progressive Aphasia

Chris J. D. Hardy, PhD; Chris Frost, MA, DipStat; Harri Sivasathiaseelan, MBBS; Jeremy C. S. Johnson, MBBS; Jennifer L. Agustus, PhD; Rebecca L. Bond, MSc; Ella Benhamou, BSc; Lucy L. Russell, BSc; Charles R. Marshall, MBBS, PhD; Jonathan D. Rohrer, MBBS, PhD; Doris-Eva Bamiou, PhD; Jason D. Warren, FRACP, PhD

Hardy et al. *NBA* 2017

PTA poorly predicts everyday hearing – and doesn't always signal peripheral hearing loss!

‘Excessive perception’: auditory emotion in dementia



bvFTD 86%, **SD** 58%, **PNFA** 7%, **AD** 41%

VBM correlate of auditory emotional symptoms

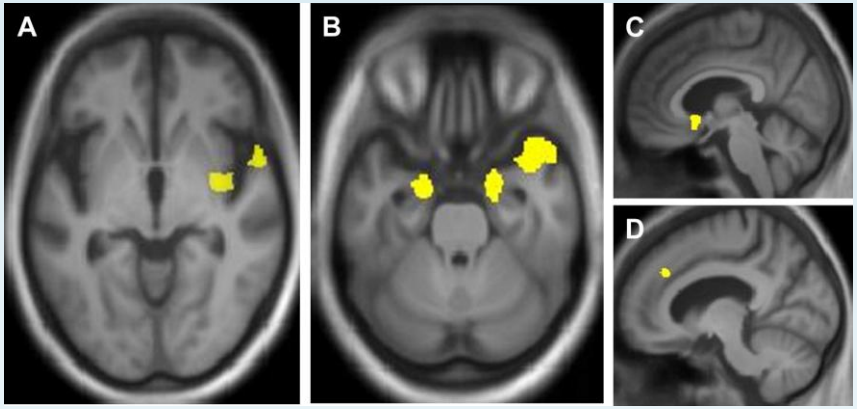


Image of the moment

Pathological fondness for noises with right temporal lobe atrophy

Jochum J van ’t Hooft [1,2,3] Jessica Jiang,[1] Lucy B Core,[1]
Yolande A L Pijnenburg,[2,3] Ross W Paterson,[1,4] Jason D Warren[1]

ELSEVIER
Cortex
Volume 67, June 2015, Pages 95-105



Research report

Auditory hedonic phenotypes in dementia: A behavioural and neuroanatomical analysis

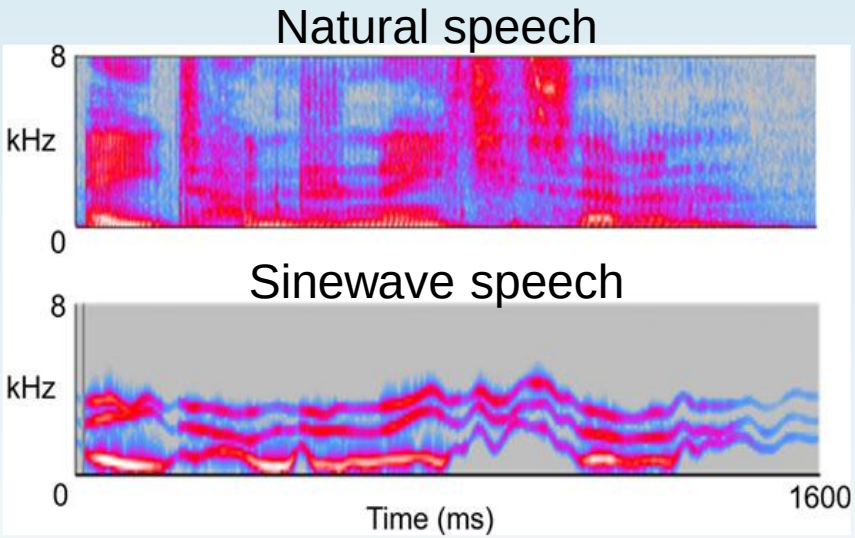
Phillip D. Fletcher, Laura E. Downey, Hannah L. Golden, Camilla N. Clark, Catherine F. Slattery, Ross W. Paterson, Jonathan M. Schott, Jonathan D. Rohrer, Martin N. Rossor, Jason D. Warren

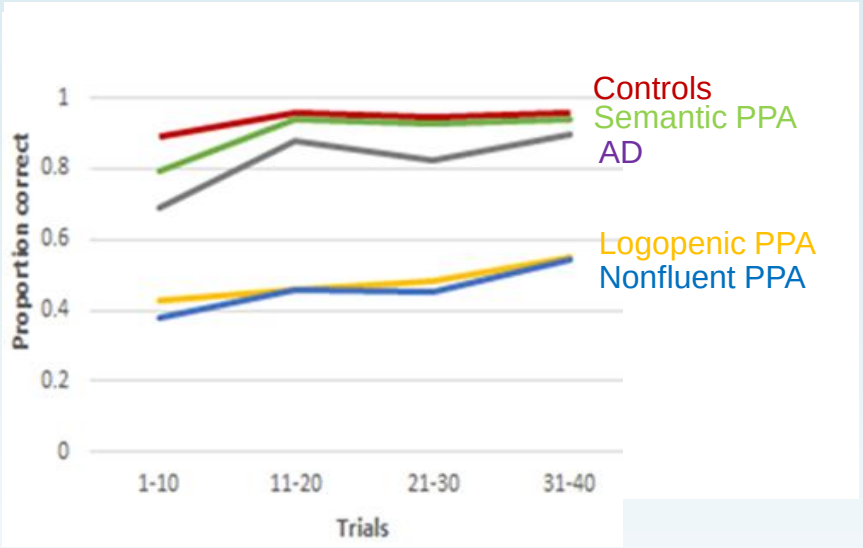
Structural neuroanatomy of tinnitus and hyperacusis in semantic dementia

Colin J Mahoney, Jonathan D Rohrer, Johanna C Goll, Nick C Fox, Martin N Rossor, Jason D Warren

Many people with dementia have heightened sensitivity to sound; tinnitus, altered auditory emotional responses and hallucinations are prominent in some syndromes

Brain hearing shows neural plasticity in dementia







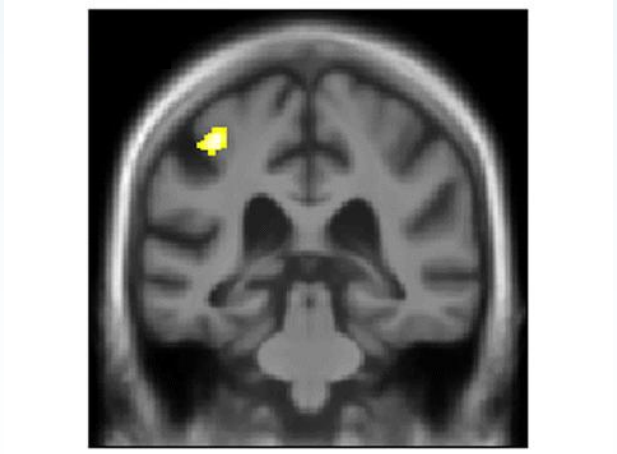
Hardy et al. Alzheimer's Research & Therapy (2018) 10:70
https://doi.org/10.1186/s13195-018-0399-2

Alzheimer's Research & Therapy

RESEARCH Open Access

Retained capacity for perceptual learning of degraded speech in primary progressive aphasia and Alzheimer's disease

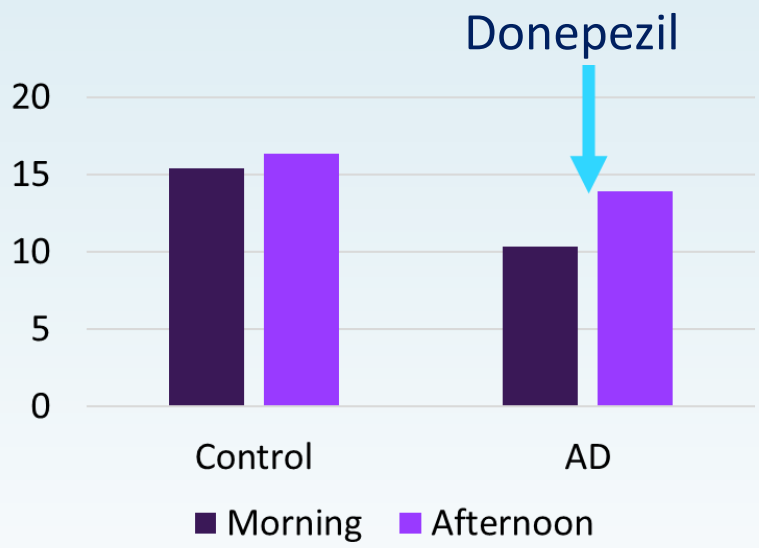
Chris J. D. Hardy[1], Charles R. Marshall[1], Rebecca L. Bond[1], Lucy L. Russell[1], Katrina Dick[1], Cono Ariti[1,2], David L. Thomas[3,4], Sonya J. Ross[1], Jennifer L. Agustus[1], Sebastian J. Crutch[1], Jonathan D. Rohrer[1], Doris-Eva Bamiou[5] and Jason D. Warren[1*]



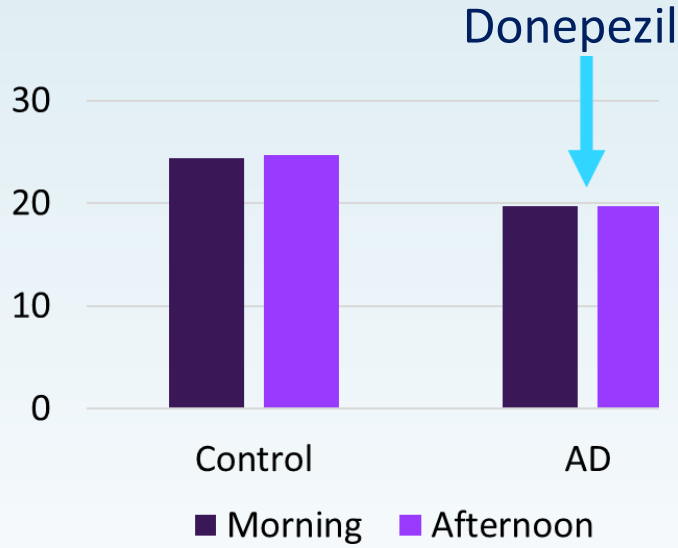
Hardy et al., *Alz Res Ther* 2018

Sensitivity to pharmacological manipulation (AchEI) in AD

Sinewave speech comprehension



Cognitive 'control' test: RMT faces



ANNALS of Clinical and Translational Neurology
Open Access
BRIEF COMMUNICATION

Donepezil enhances understanding of degraded speech in Alzheimer's disease

Chris J. D. Hardy, Yun T. Hwang, Rebecca L. Bond, Charles R. Marshall, Basil H. Ridha, Sebastian J. Crutch, Martin N. Rossor & Jason D. Warren

Dementia Research Centre, Department of Neurodegenerative Disease, Institute of Neurology, University College London, London, United Kingdom

Hardy et al., *Ann Clin Transl Neurol* 2017

Future directions

- **Clinical brain hearing tests for dementia detection and Rx planning**

  Need and opportunity – particularly diverse populations – but challenging

- **Harnessing auditory brain plasticity**

  View to future adjunctive neurorehab and brain repair in dementia

- **Cross-modal (audio-visual) processing**

  Senses must work together in the real world – neurobiological and therapeutic opportunities

- **Auditory event processing and the hippocampus**

  Largely overlooked in dementia research - sound is arguably the prime hippocampal modality

- **Hearing for living in dementia**

  Beyond deafness to the spectrum of behavioural and emotional responses to sounds

- **Soundscaping for people with dementia**

  Bespoke digital dementia-friendly listening spaces – with technical collaborators

Take away messages

- **The link between hearing and dementia is complex and bidirectional**

  Hearing impairment may be cause, catalyst **and** consequence – synergistic and dynamic

- **‘Brain hearing’ changes signal dementia and differentiate diseases**

  Hearing-based dementia proximity markers, ‘brain stress tests’, therapeutic plasticity indices…

- **Validated tests and treatments for brain hearing are needed**

  Brain hearing (not PTA) predicts real world function and diagnosis – and informs interventions

- **Peripheral hearing should always be assessed and optimised**

  Poor quality input signal amplifies dementia effects – protecting hearing protects brain function

- **Audiologists can support dementia diagnosis, care and research**

  Partnership with multidisciplinary memory clinics should be the goal

- **Neurologists should ask about hearing!**

Acknowledgments



Chris Hardy & Jessica Jiang

Clinical neurology
Jeremy Johnson
Harri Sivasathiaseelan
Philip Fletcher
Colin Mahoney
Camilla Clark

Neuropsychology
Johanna Goll
Hannah Golden
Julia Hailstone
Ben Levett
Lucy Core
Sophie Froud
Elia Benhamou

Speech & language therapy
Anna Volkmer
Holly Robson

Neuro-otology
Doris-Eva Bamiou
Rohani Omar

Collaborators
Tim Griffiths
Maria Chait
Patrick Naylor
Emma Holmes
Aaron Seitz
Nick Tyler
eargym®
Charles Marshall

...and all our patients and families

UCL MSc in Dementia: https://www.ucl.ac.uk/prospective-students/graduate/taught-degrees/dementia-neuroscience-clinical-practice-msc