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Large-scale, multimodal, open imaging: the CamCAN example

Rik Henson

MRC CBU

Cognestic Summer School, Sep 2023

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Healthy Ageing

- People are living longer, and the proportion of most world populations that are in “old age” is increasing

- Ageing brings cognitive problems, owing to brain changes, so understanding how ageing of the brain affects cognition might help us maintain cognitive abilities for longer, and so help people function independently for longer

- Brain structure and function can be measured in many ways (sMRI, fMRI, DTI, MEG…) and relating to individual differences requires large samples…

… a “large-scale, multi-modal” approach…

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Ageing Brains (MRI)

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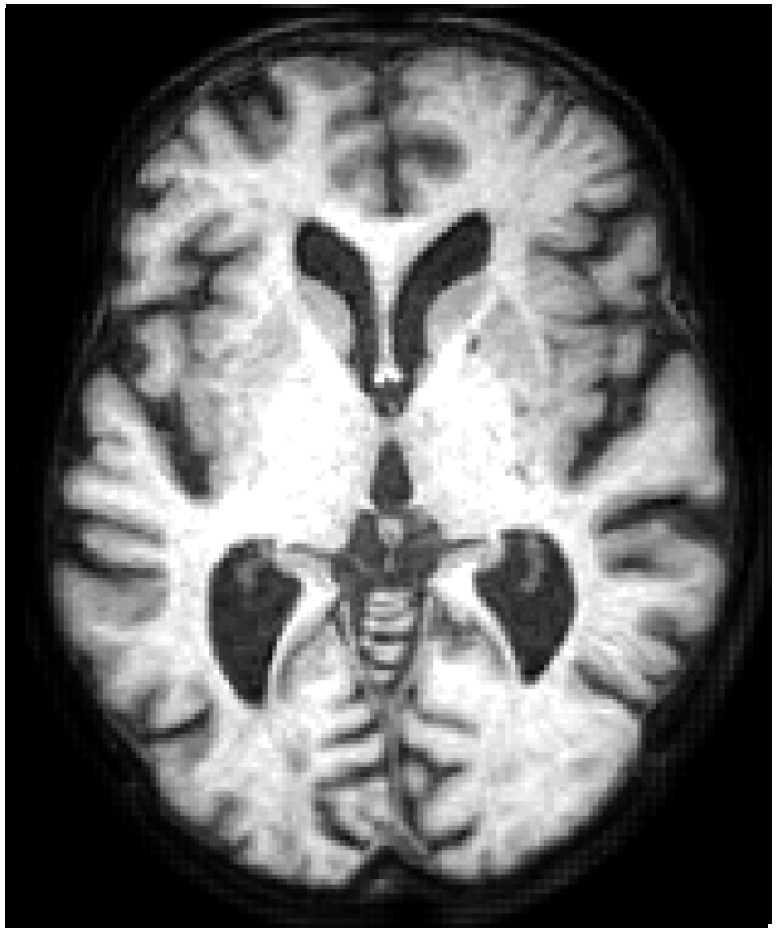

CamCAN

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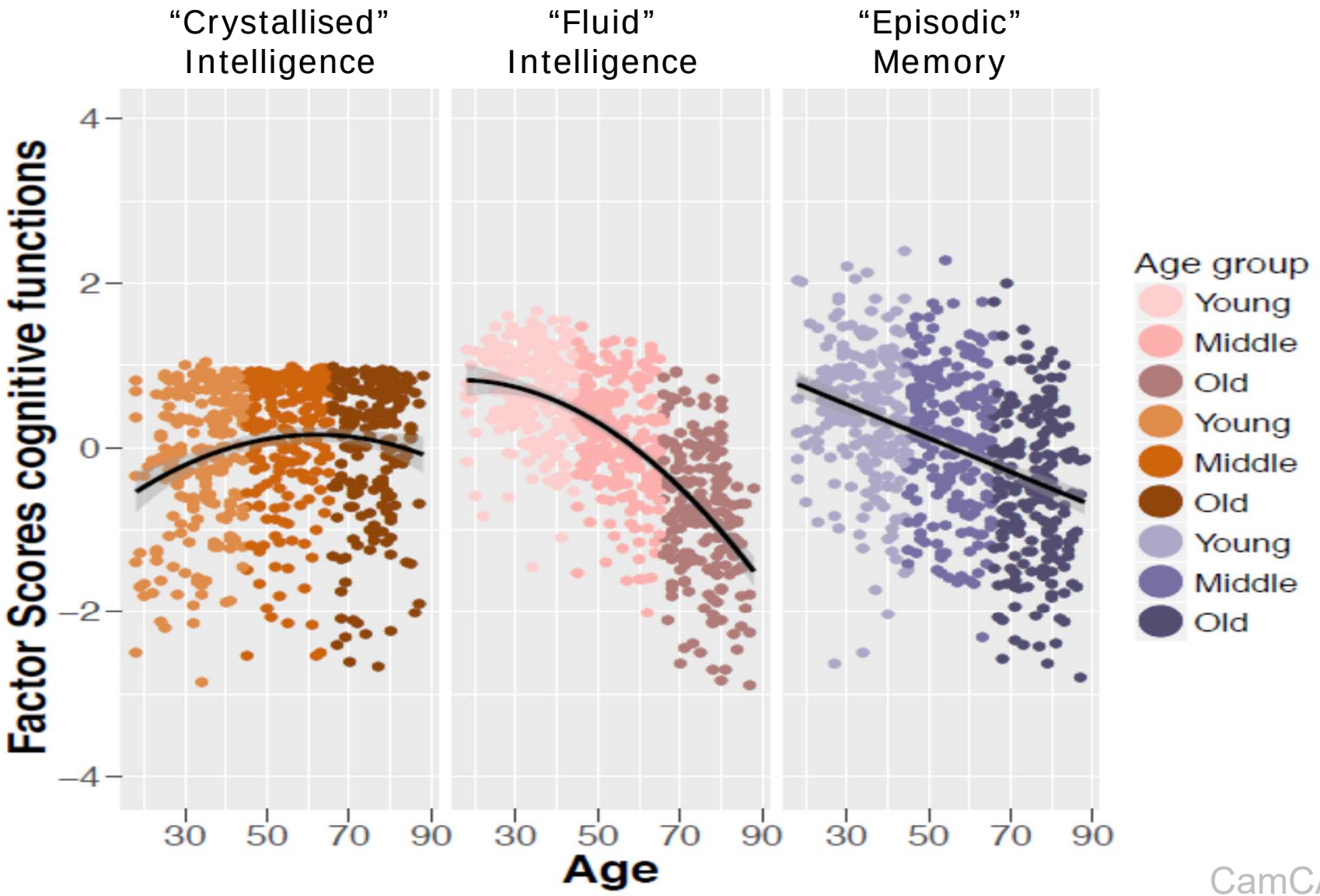
Ageing Cognition



CamCAN

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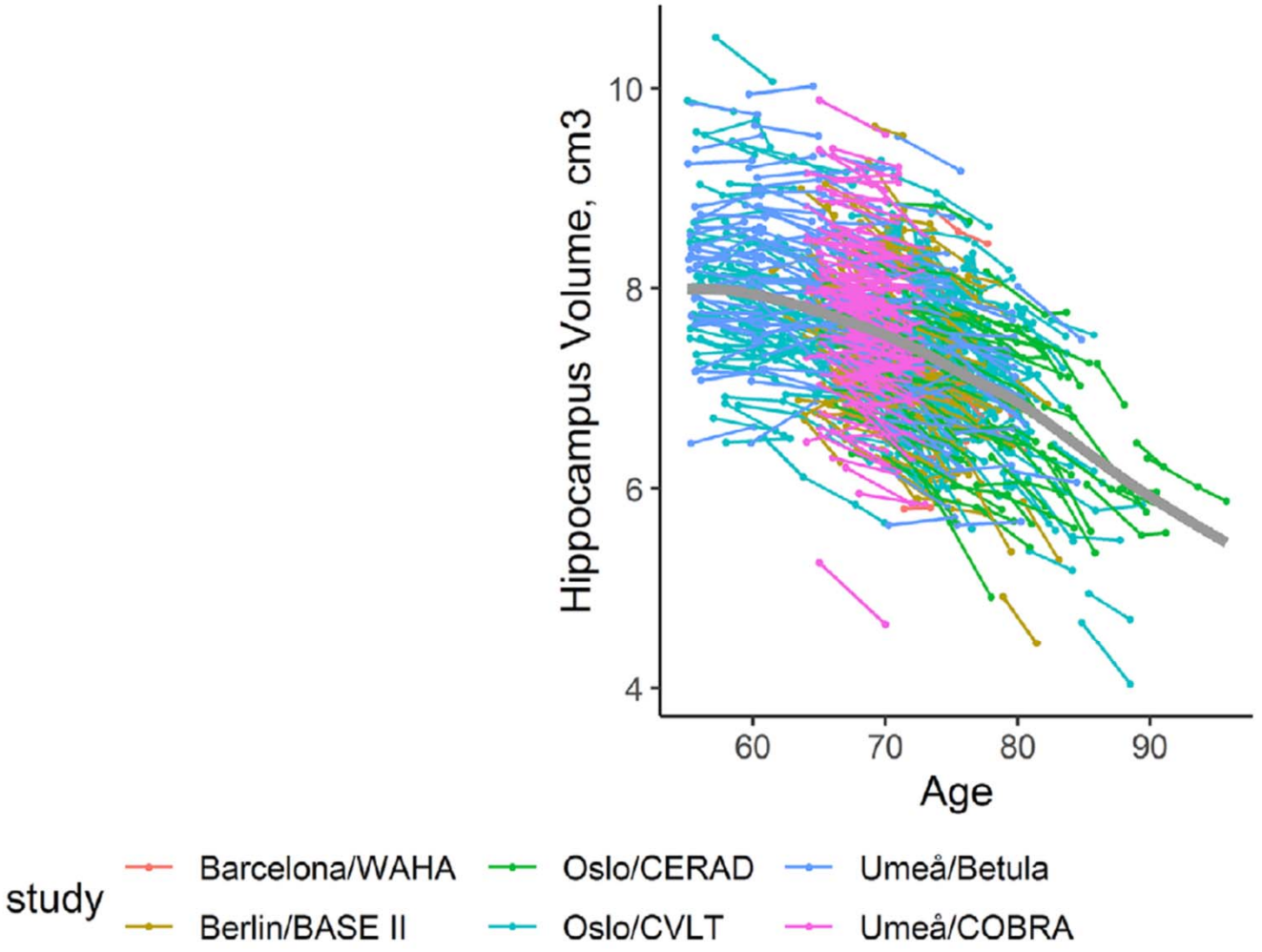
More than Brain Structure?

=> ***functional*** *connectivity/reorganisation/compensation…?*



Gorbach et al (2020), Alz & Dem

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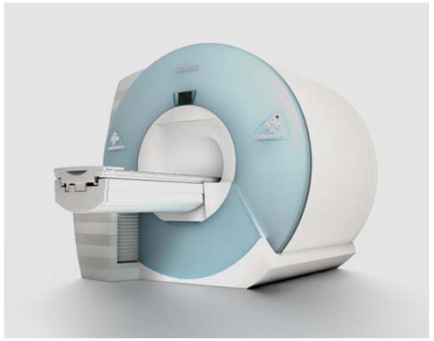
MRI & MEG

- MRI has been used for many years to study brain ageing
- **Structural** MRI (sMRI) measures (static) brain anatomy
- **Functional** MRI (fMRI) measures dynamic activity / connectivity, eg related to specific cognitive functions
- However, fMRI response is a function of 1) **neural** and 2) **haemodynamic** characteristics (vasculature)…
- …and ageing likely to affect **both**
- Furthermore, haemodynamics are **slow** (seconds)…



- MEG (and EEG) provide direct measure of **neural** activity…
- … at millisecond resolution, revealing rich repertoire of oscillatory activity above 0.1Hz (fMRI)
- MEG has greater spatial degrees of freedom than EEG, ie., can resolve more nodes/states

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Cambridge Centre for Ageing & Neuroscience (CamCAN)

http://www.cam-can.org/

- 2010: ~2700 recruited after ~9000 calls (opt-out), so population-derived
  2-hour home interview (eg, lifestyle)
- 2011: 100 per decade 18-88, from 3000
  ~7 hours of cognitive tests
  1 hour MRI (T1, T2, DTI, MTR, fMRI)
  0.5 hour of MEG
- 2016: data released – over 2000 downloads, over 100 publications:
  https://camcan-archive.mrc-cbu.cam.ac.uk/dataaccess/

BBSRC bioscience for the future

LifeBrain

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Cam-CAN

cam-can.org/index.php?content=dataset

Cambridge Centre for Ageing and Neuroscience

THE SCIENCE OF AGEING

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Cam-CAN Data Repository

The data repository for the **Cambridge Centre for Ageing and Neuroscience (Cam-CAN) dataset** can be found here

Data Access Portal

Worldwide Usage

The CamCAN dataset has been requested by over 1000 researchers worldwide (number last updated 26/01/2022; map last updated 11/05/2020).

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Cam-CAN Data Access Portal

camcan-archive.mrc-cbu.cam.ac.uk/dataaccess/datarequest.php

CamCAN Data Use Agreement

I request access to data collected by the Cambridge Centre for Ageing Neuroscience (CamCAN) for the purpose of scientific investigation, teaching or the planning of clinical research studies and agree to the following terms:

1. I will receive access to de-identified data and will not attempt to establish the identity of, or attempt to contact, any of the CamCAN participants.
2. I will not further disclose these data beyond the uses outlined in this agreement.
3. I will use the data only for the purposes of non-commercial, ethical research or teaching specified in this application and to seek the approval of CamCAN (via the CamCAN Administrator) for any other proposed use.
4. I will require anyone on my team who utilizes these data, or anyone with whom I share these data, to comply with this data use agreement. Note, for this reason, students should ask their supervisors to apply on their behalf.
5. I will not copy data to external storage locations (such as dropbox, google drive or external harddrives) and understand data must remain on my institution's server.
6. I will respond promptly and accurately to requests to update this information.
7. I will comply with any rules and regulations imposed by my institution and its institutional review board in requesting these data.
8. I understand that it is my responsibility to check data for errors, and that CamCAN is not responsible for the consequences of unreported errors in the data. I also agree to make any such errors known to CamCAN as soon as possible.
9. I understand that CamCAN cannot guarantee exclusive use of these data or police potential overlaps of interest with other researchers.
10. I agree to make any publications that arise from use of CamCAN data open-access. Any derived data and processing scripts used to produce those derived data will also be made available on a suitable open-access data repository.
11. I will acknowledge the CamCAN project as a source of data and include language similar to the following:
    "Data collection and sharing for this project was provided by the Cambridge Centre for Ageing and Neuroscience (CamCAN). CamCAN funding was provided by the UK Biotechnology and Biological Sciences Research Council (grant number BB/H008217/1), together with support from the UK Medical Research Council and University of Cambridge, UK."
12. I will include language similar to the following in the methods section of my manuscripts in order to accurately acknowledge data gathering by the CamCAN investigators. Depending upon the length and focus of the article, it may be appropriate to include more or less than the example below. However, inclusion of some variation of the language shown below is mandatory.
    "Data used in the preparation of this work were obtained from the CamCAN repository (available at http://www.mrc-cbu.cam.ac.uk/datasets/camcan/), (Taylor et al., 2016, Shafto et al., 2015). Citation:

    Taylor, J.R., Williams, N., Cusack, R., Auer, T., Shafto, M.A., Dixon, M., Tyler, L.K., CamCAN, Henson, R.N. (2016). The Cambridge Centre for Ageing and Neuroscience (CamCAN) data repository: Structural and functional MRI, MEG, and cognitive data from a cross-sectional adult lifespan sample. NeuroImage. doi: 10.1016/j.neuroimage.2015.09.018.

    Shafto, M.A., Tyler, L.K., Dixon, M., Taylor, J.R., Rowe, J.B., Cusack, R., Calder, A.J., Marslen-Wilson, W.D., Duncan, J., Dalgleish, T., Henson, R.N., Brayne, C., CamCAN, & Matthews, F.E. (2014). The Cambridge Centre for Ageing and Neuroscience (CamCAN) study protocol: a cross-sectional, lifespan, multidisciplinary examination of healthy cognitive ageing. BMC Neurology, 14(204). doi:10.1186/s12883-014-0204-1.

I understand that failure to abide by these guidelines will result in termination of my privileges to access CamCAN data.

I understand that any details I enter on this website and any other communication I have with the CamCAN team will be handled according to our data use policy, and I agree for my data to be stored and used in this way

☐ **I agree to the above terms and conditions**

submit

Cam-CAN Data Access Portal

camcan-archive.mrc-cbu.cam.ac.uk/dataaccess/details.php

for each dataset requested. Cognitive data will also appear separate directories. For physiological and demographic data (homeint_*, epaq_*, scq_*, additional_*), a tab-delimited text file will be added to your home space containing the approved variables.

Raw MRI data and all MEG conform to BIDS standard. Pre-processed MRI data are stored in aa folders for each stage in the pipeline. MRI and MEG pre-processing scripts are also available:

Automatic Analysis (aa) User Master Script (UMS) for MRI
Automatic Analysis (aa) Recipe (XML) for MRI
Automatic Analysis (aa) User Master Script (UMS) for MEG
Automatic Analysis (aa) Recipe (XML) for MEG
MindBoggle Docker Shell Script
Mindboggle docker image installation instructions: https://mindboggle.readthedocs.io/en/latest

You will automatically get a file in your home directory called "standard_data.csv", which contains, for each of the N=2681 unique CamCAN IDs (CCID) who took the Home Interview: the participant's Age (at time of Home Interview, in years), biological Sex (Male/Female), Handedness (on Edinburgh scale from -100 to +100), whether any MRI data were acquired before or after the scanner coil change (see Data Issues tab at top of webapge) and finally what MTI TR was used (50ms or 30ms). (There are additional "participant_data.tsv" files within the BIDS folders for each imaging modality of raw data, which will contain a subset of participants who had valid data for that modality.)

The demographic data are from Stage I (Home Interview), and includes a range of interview and self-completion questionnaires designed to collect lifestyle variables, demographic data, physical and social activity etc. The lists are divided into four categories: Home Interview (homeint_ prefix), Electronic Personal Assessment Questionnaire (epaq_ prefix), Self-Completion Questionnaire (scq_ prefix), Additional Scores (additional_ prefix).

Please select the datasets and variables you would like to use from the following list:

Variable Name	Description
Filter list..	
___MEG	
_____Maxfiltered	
_____No movement compensation	
imaging_meg_mf_nomc_rest	Imaging Data: MEG Resting state from phase II
imaging_meg_mf_nomc_smt	Imaging Data: MEG active Sensorimotor task from phase II
imaging_meg_mf_nomc_pass	Imaging Data: MEG passive Sensory (audiovisual) from phase II
_____With movement compensation	
imaging_meg_mf_rest	Imaging Data: MEG Resting state from phase II
imaging_meg_mf_smt	Imaging Data: MEG active Sensorimotor task from phase II
imaging_meg_mf_passive	Imaging Data: MEG passive Sensory (audiovisual) from phase II
_____Transformed to default space	
imaging_meg_rest_transdef_mf	Imaging Data: MEG Resting state from phase II

Requested Variables

Submit

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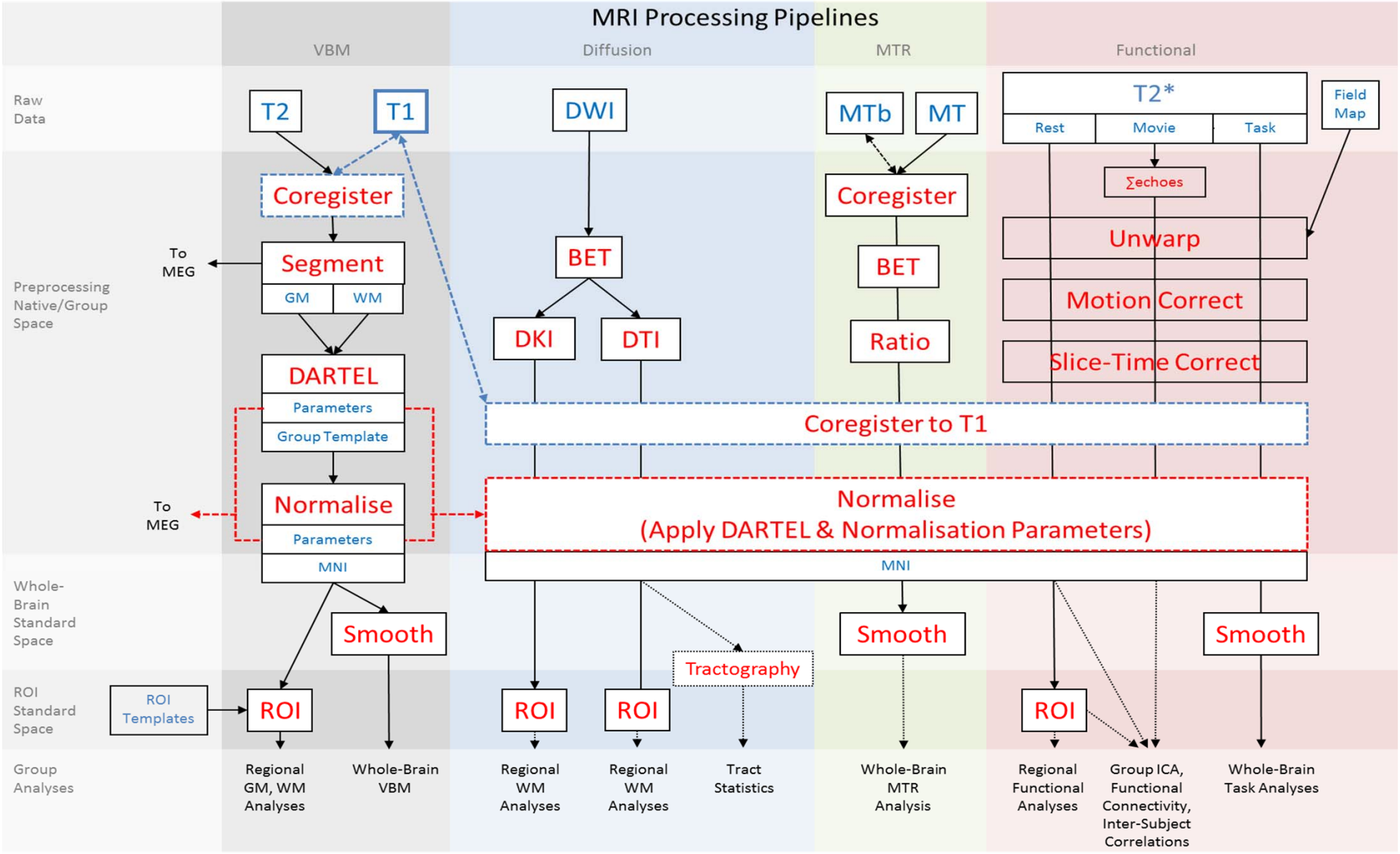
Pipelines

Taylor et al. (2017), Neuroimage



Scientific Publications

For CamCAN members and affiliates with approved projects, please refer to this page for publication conditions; for non-CamCAN researchers with approved access via the data-sharing portal, please refer to this page for publication conditions.

Preprints

Henson, R.N., Olszowy, W., Tsvetanov, K.A., Cam-CAN & Zeidman, P. Evaluating models of the ageing BOLD response. BioRXiv. [Cam-CAN Author list 14] Open Access Preprint

Henriques, R.N., Henson, R.N., Cam-CAN, Correia, M.M. Unique information from common diffusion MRI models about white-matter differences across the human adult lifespan. ArXiv. [Cam-CAN Author list 14] Open Access Preprint

Bingjiang, L., Tsvetanov, K.A., Tyler, L.K., Clarke, A., Cam-CAN, Amos, W. Genetic signatures of human brain structure: A comparison between GWAS and relatedness-based regression. BioRxiv. [Cam-CAN Author list 13] Open Access Preprint

Peer-Review

In press

2023

Lugtmeijer, S., Geerligs, L., Tsvetanov, K.A., Mitchell, D.J., Cam-CAN & Campbell, K.L. (2023). Lifespan differences in visual short-term memory load-modulated functional connectivity. Neuroimage, 270, 119982. [Cam-CAN Author list 14] DOI

King, D.L.O., Henson, R.N., Kievit, R., Wolpe, N., Brayne, C., Tyler, L.K., Rowe, J.B., Cam-CAN & Tsvetanov, K.A. (2023). Distinct components of cardiovascular health are linked with age-related differences in cognitive abilities. Scientific Reports, 13:978. [Cam-CAN Author list 14] DOI

Mitchell, D., Mousley, A., Shafto, M., Cam-CAN, Duncan, J. (2023). Neural contributions to reduced fluid intelligence across the adult lifespan. Journal of Neuroscience [Cam-CAN Author list 14] DOI

2022

Wu, S., Tyler, L.K., Henson, R.N., Rowe, J.B., Cam-CAN, Tsvetanov, K.A. (2022). Cerebral blood flow predicts multiple demand network activity and fluid intelligence across the adult lifespan. Neurobiology of Aging, 121, 1-14 [Cam-CAN Author list 14] DOI

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Outline

- Vascular changes (fMRI+MEG)
- Latency effects (MEG+DTI)
- Effects of APO-E (sMRI+fMRI+MEG)
- Cognitive Reserve (sMRI+fMRI)

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Outline

- Vascular changes (fMRI+MEG)
- Latency effects (MEG+DTI)
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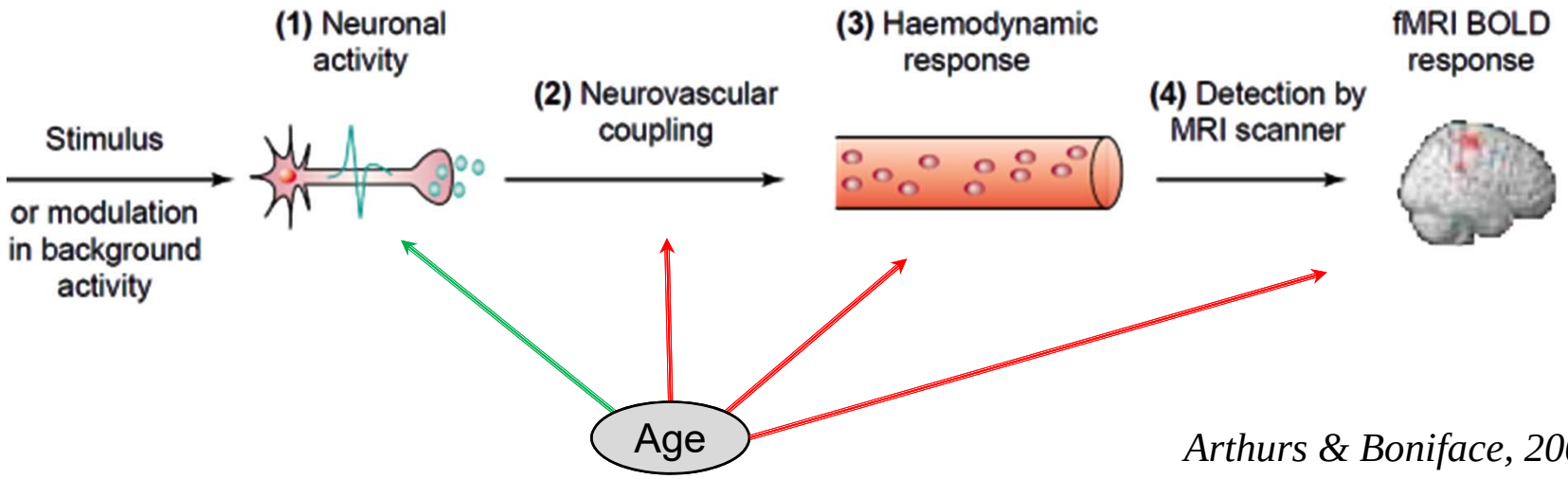
- Cognitive Reserve (sMRI+fMRI)

Vascular Factors

1. Adjust data… e.g, adjust BOLD activation by RSFA (Tsvetanov et al., 2015)



Arthurs & Boniface, 2002

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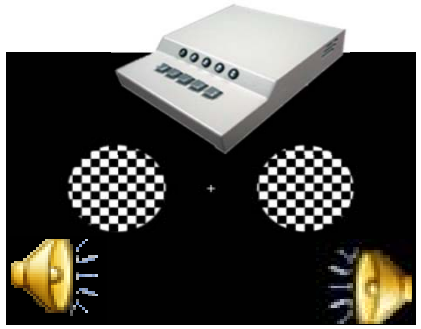
Sensory Evoked Responses in fMRI

◆ Human Brain Mapping 36:2248–2269 (2015) ◆

The Effect of Ageing on fMRI: Correction for the Confounding Effects of Vascular Reactivity Evaluated by Joint fMRI and MEG in 335 Adults

Kamen A. Tsvetanov,[1]* Richard N. A. Henson,[2] Lorraine K. Tyler,[1] Simon W. Davis,[1] Meredith A. Shafto,[1] Jason R. Taylor,[2,3] Nitin Williams,[2] Cam-CAN,[4] and James B. Rowe[2,5]



Kamen Tsvetanov

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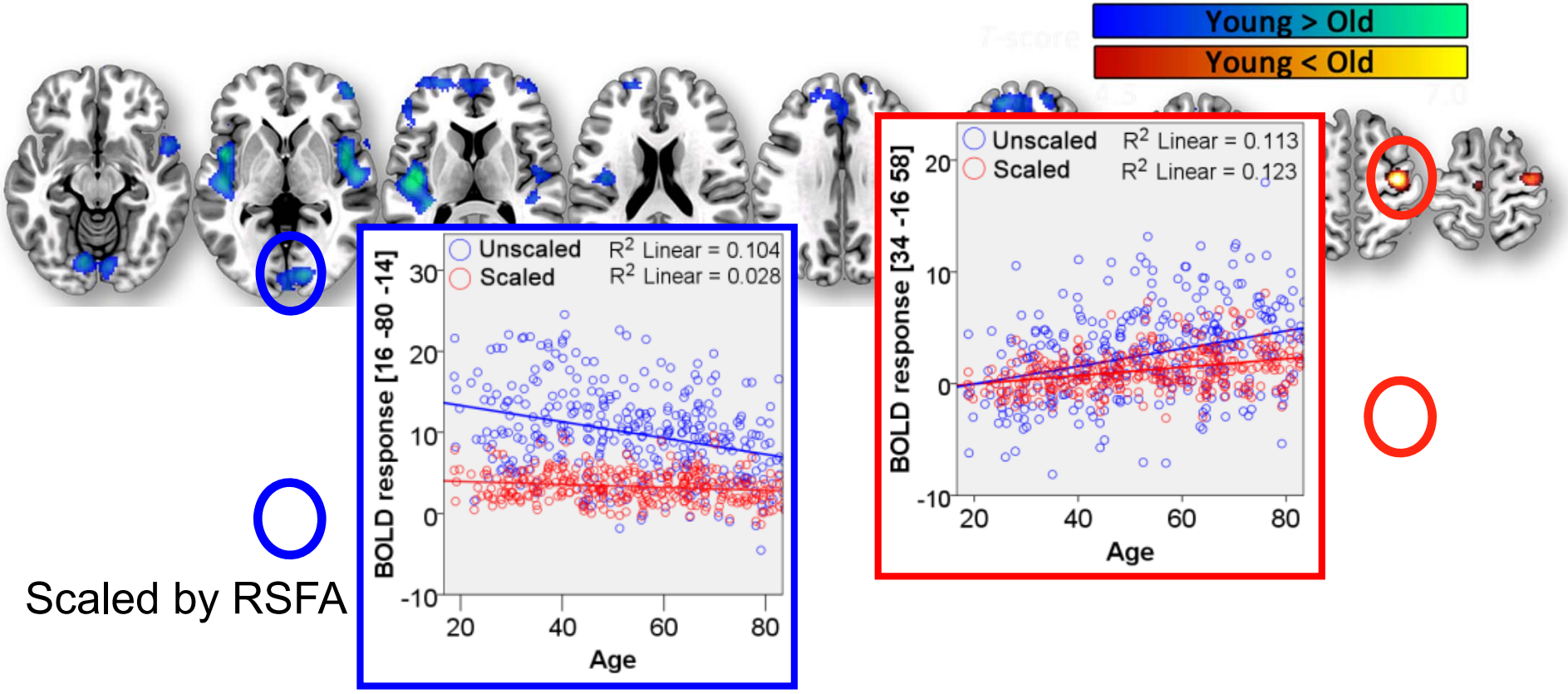
Sensory Evoked Responses in fMRI

Effect of Age, unscaled by RSFA



Scaled by RSFA

Tsvetanov et al (2015), Hum. Brain. Mapping

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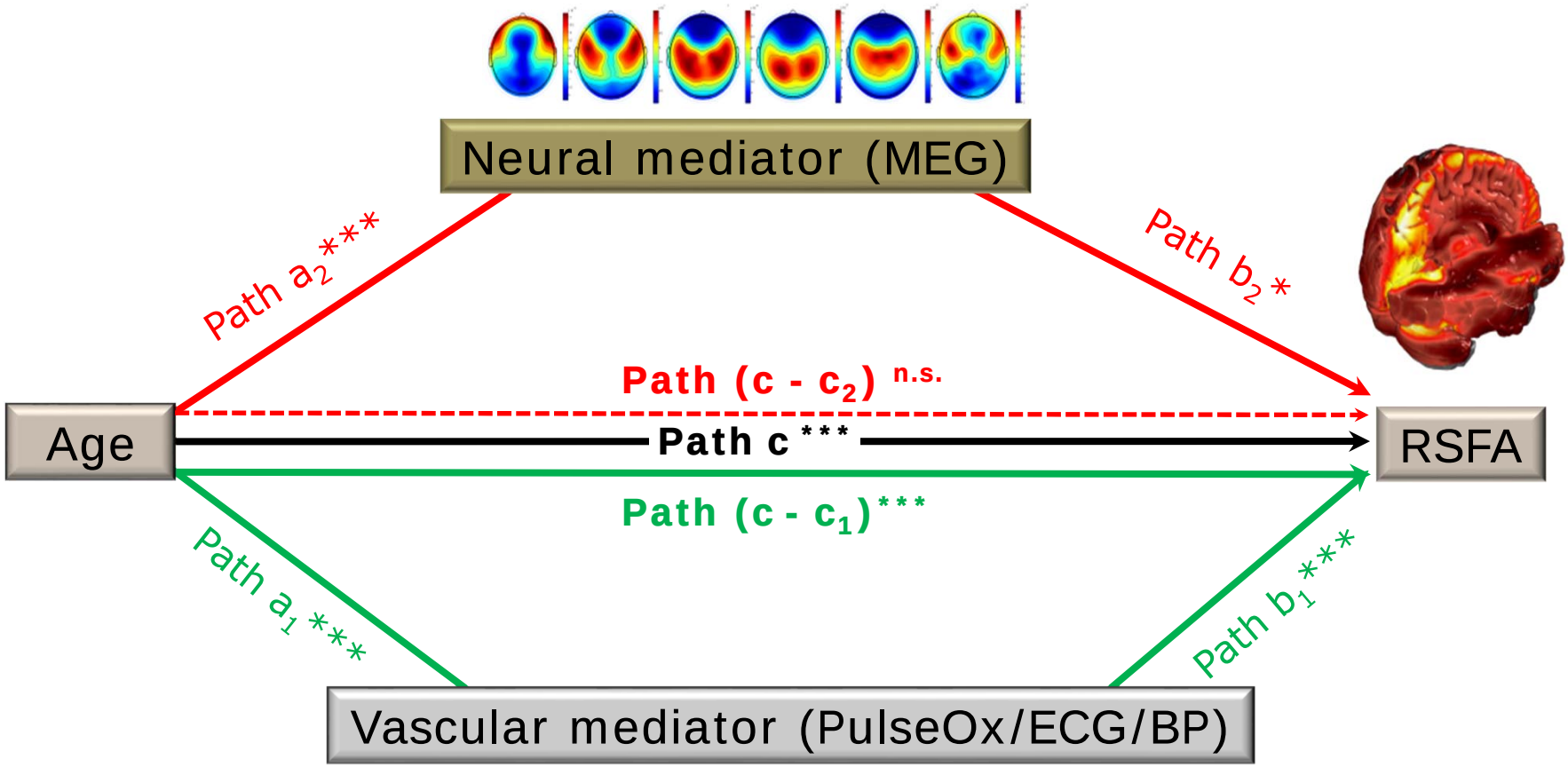
Is RSFA scaling fair?



Tsvetanov et al (2015), Hum. Brain. Mapping

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Vascular Conclusions

- Many age-related fMRI (de)activations are likely to reflect vascular rather than neural changes…

Tsevtanov et al (2015), Hum. Brain. Mapping

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Vascular Factors

1. Adjust data… e.g, adjust BOLD activation by RSFA (Tsvetanov et al., 2015)
   or BOLD connectivity by mean FC (Geerligs et al., 2017)

2. …or have more complex model, e.g, HaemoDynamic Modelling, HDM…

Cold Spring Harbor Laboratory

bioRχiv

THE PREPRINT SERVER FOR BIOLOGY

New Results

Follow this preprint

Evaluating models of the ageing BOLD response

R.N. Henson, W. Olszowy, K.A. Tsvetanov, Cam-CAN, P. Zeidman

doi: https://doi.org/10.1101/2023.08.24.554634

This article is a preprint and has not been certified by peer review [what does this mean?].

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Abstract Full Text Info/History Metrics Preview PDF

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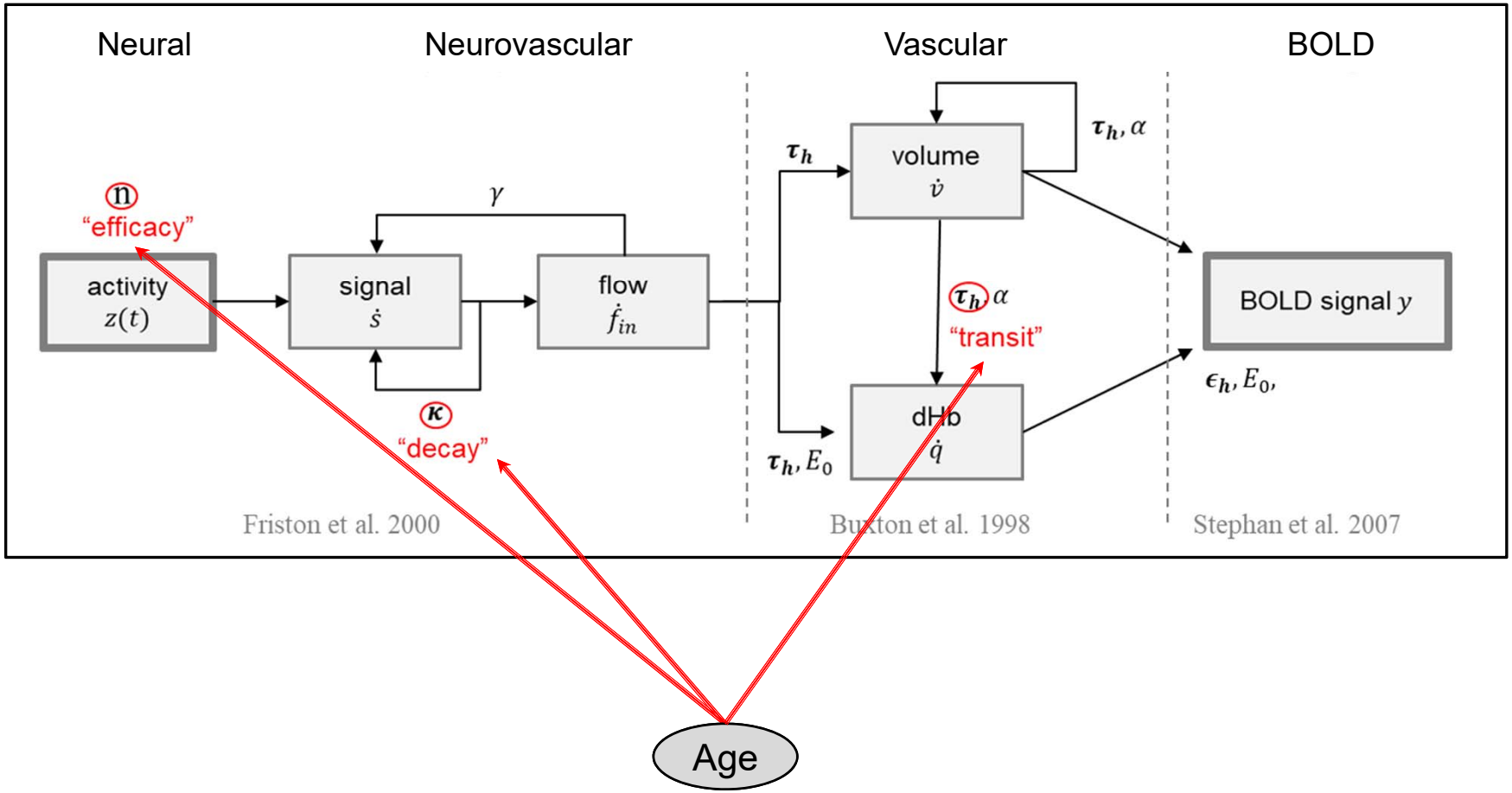
Haemodynamic Modelling (HDM)



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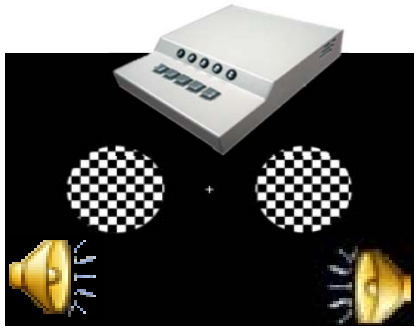
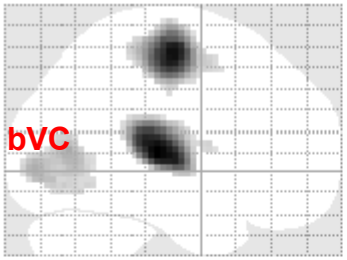
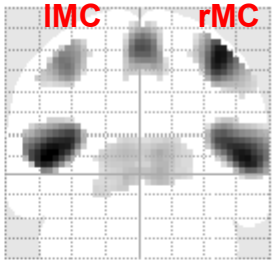
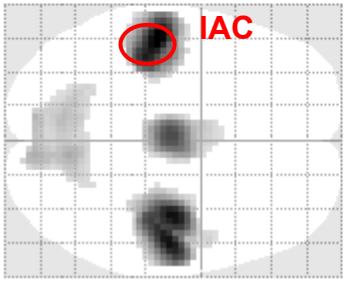
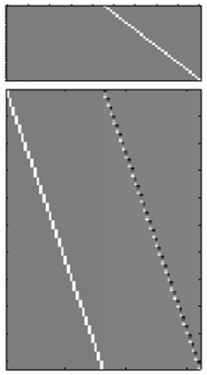
Haemodynamic Modelling (HDM)

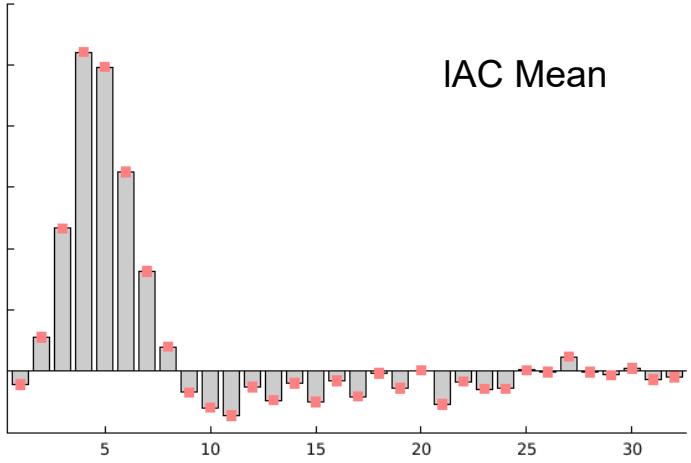


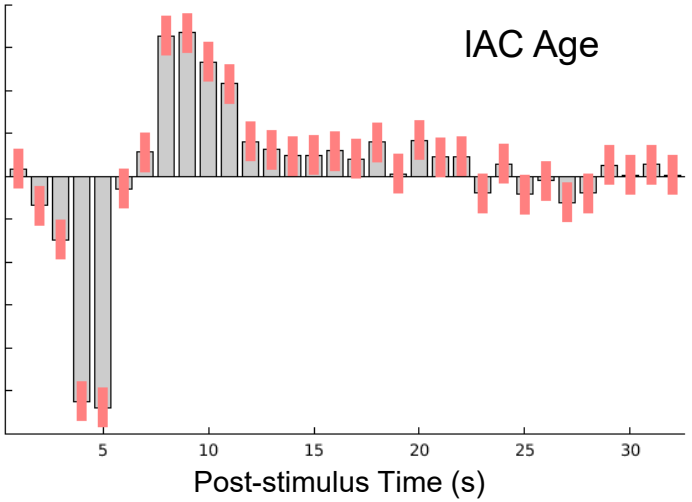












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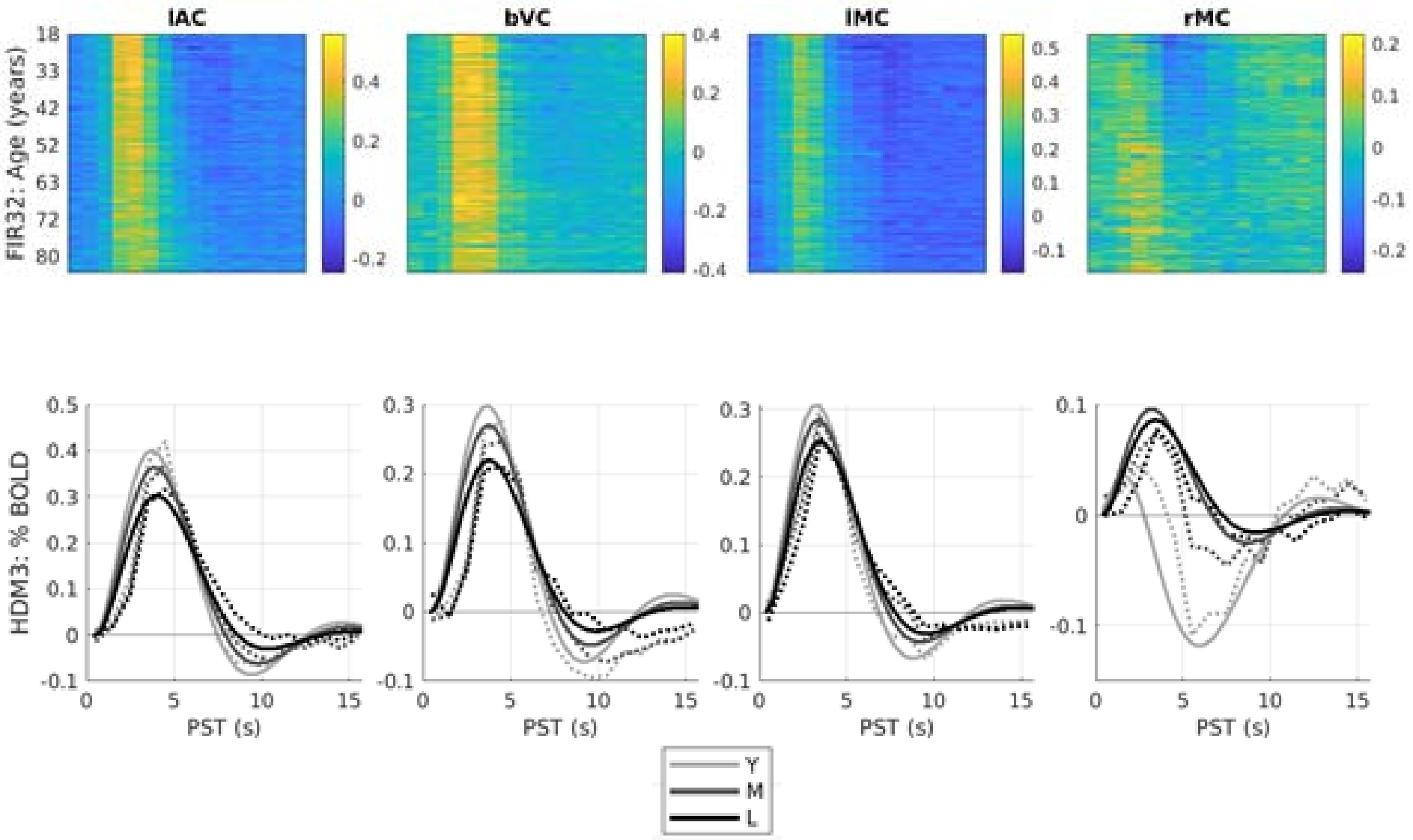
Haemodynamic Modelling (HDM)



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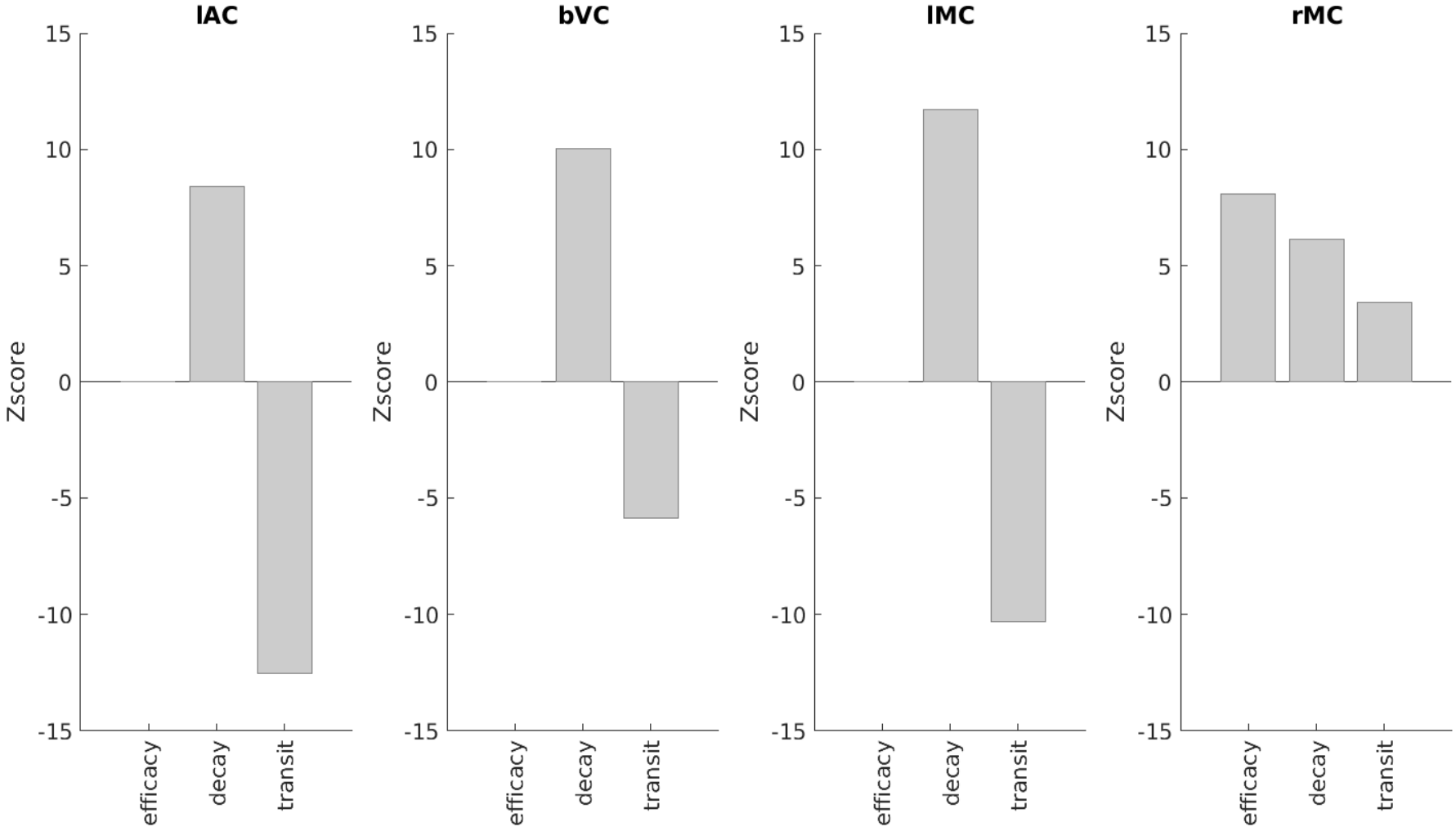
Haemodynamic Modelling (HDM)

Effect of Age (PEB)



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Vascular Conclusions

- Many age-related fMRI (de)activations are likely to reflect vascular rather than neural changes…

Tsevtanov et al (2015), Hum. Brain. Mapping

- …specifically in vasodilatory signal decay and haemodynamic transit time (though not in all brain regions, eg right motor cortex)

Henson et al (preprint), BioRXiv

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Vascular Factors

1. Adjust data… e.g, adjust BOLD activation by RSFA (Tsvetanov et al., 2015)
   or BOLD connectivity by mean FC (Geerligs et al., 2017)

2. …or have more complex model, e.g, HaemoDynamic Modelling, HDM,
   Dynamic Causal Modelling, DCM…

The Journal of Neuroscience, March 16, 2016 • 36(11):3115–3126 • 3115

Behavioral/Cognitive

Extrinsic and Intrinsic Brain Network Connectivity Maintains Cognition across the Lifespan Despite Accelerated Decay of Regional Brain Activation

Kamen A. Tsvetanov,[1,7] Richard N.A. Henson,[2,7] Lorraine K. Tyler,[1,7] Adeel Razi,[3,4] Linda Geerligs,[2,7] Timothy E. Ham,[5] James B. Rowe,[2,5,6,7] and Cambridge Centre for Ageing and Neuroscience[7]

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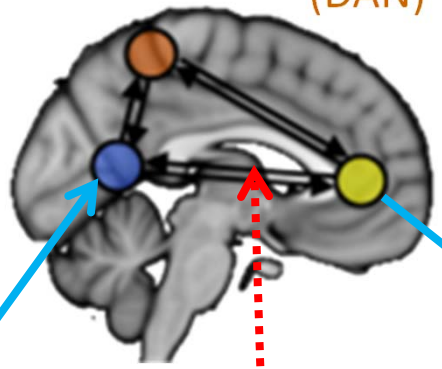
Resting state DCM

Connectivity Model

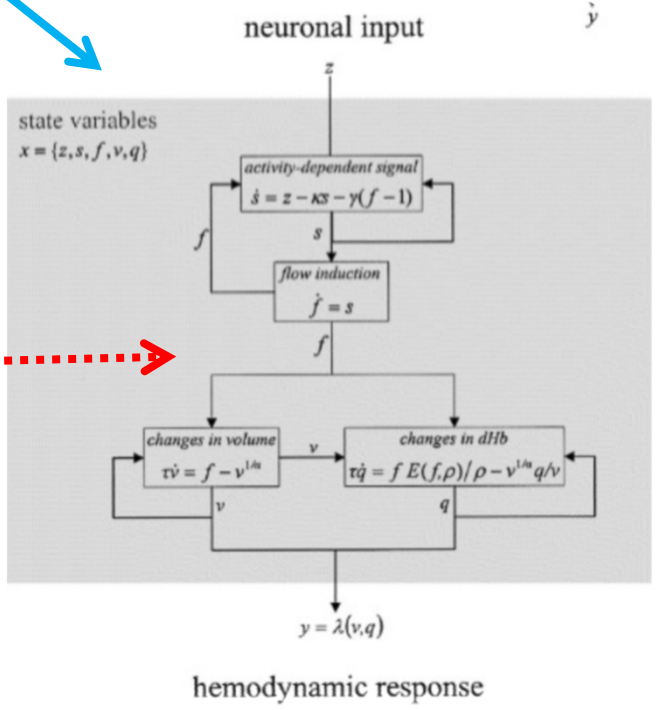
Dorsal Attention Network (DAN)

Default Mode Network (DMN)

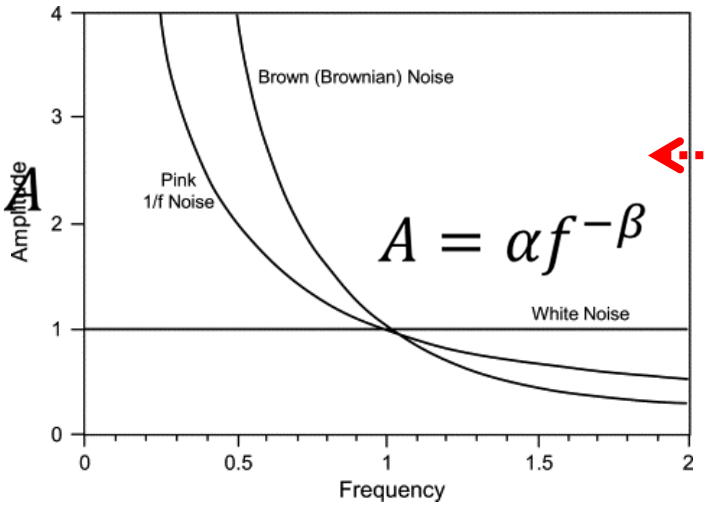
Salience Network (SN)



Haemodynamic Model



Activity Model



Age

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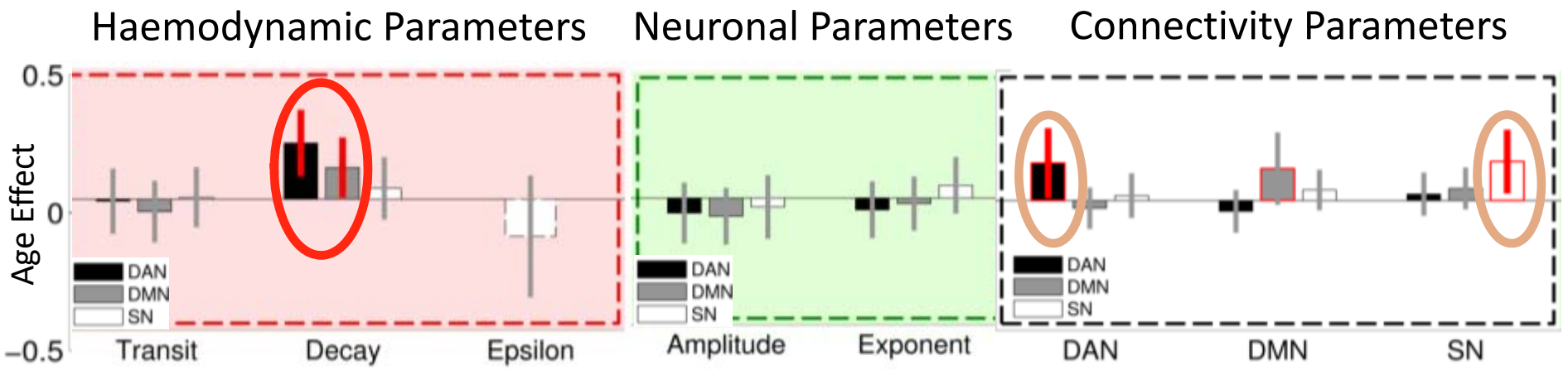
Resting state DCM

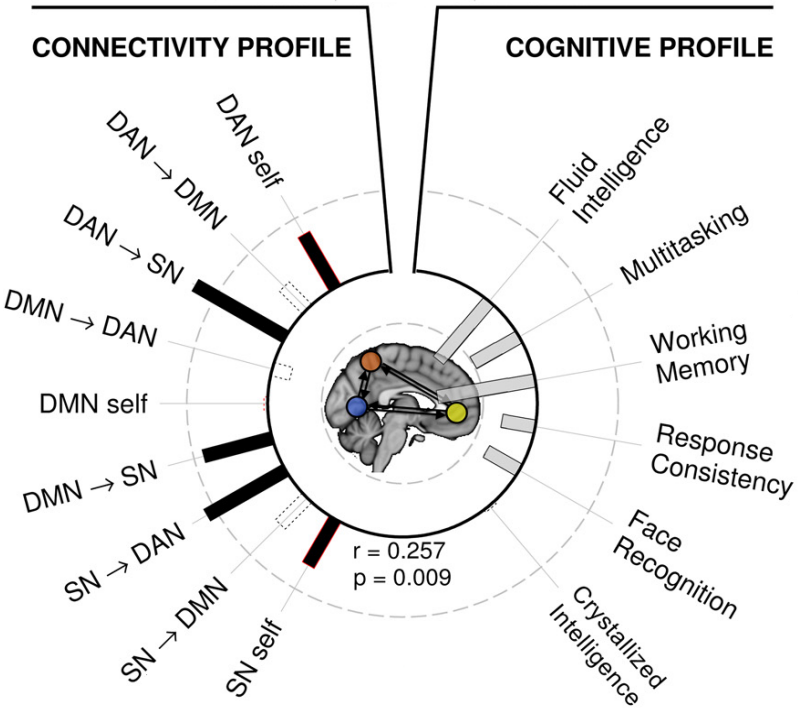
Effects of Age on DCM parameters:

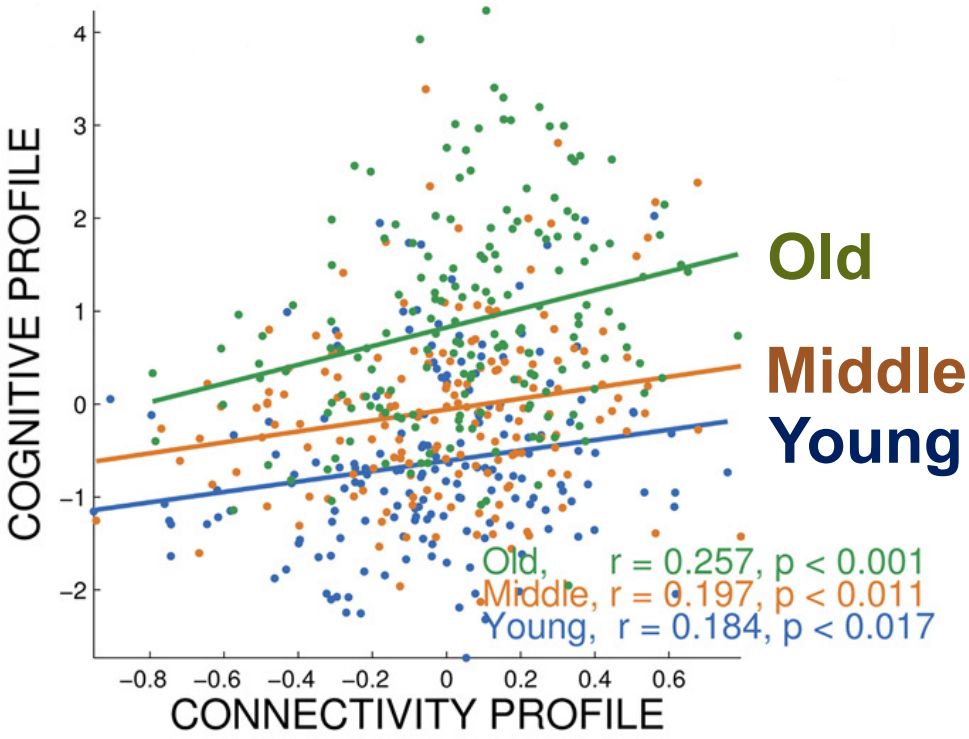


Tsvetanov et al (2016) Journal of Neuroscience

Effective Connectivity (DCM)

Canonical Correlation Analysis (CCA):





Tsvetanov et al (2016) Journal of Neuroscience

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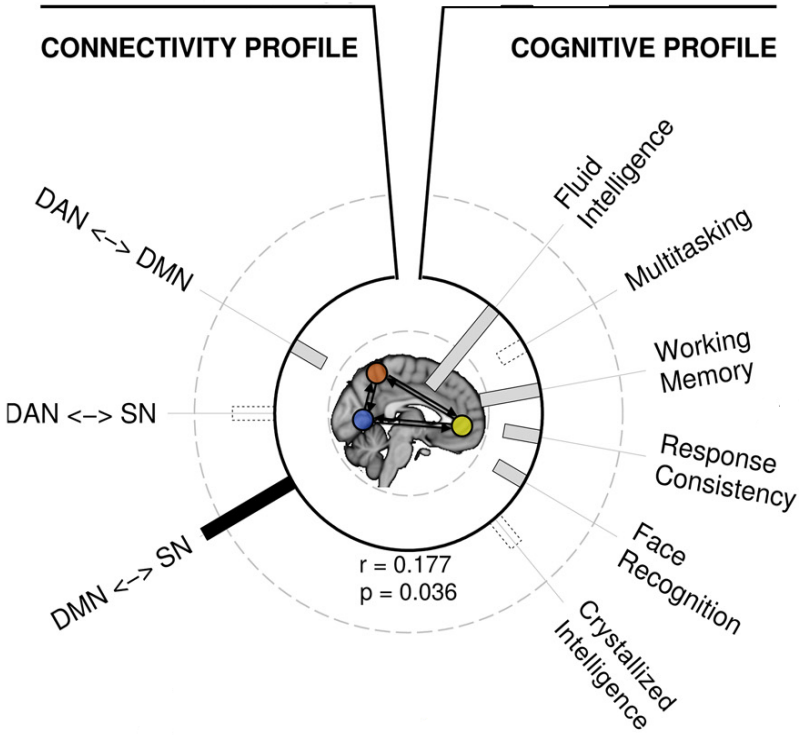
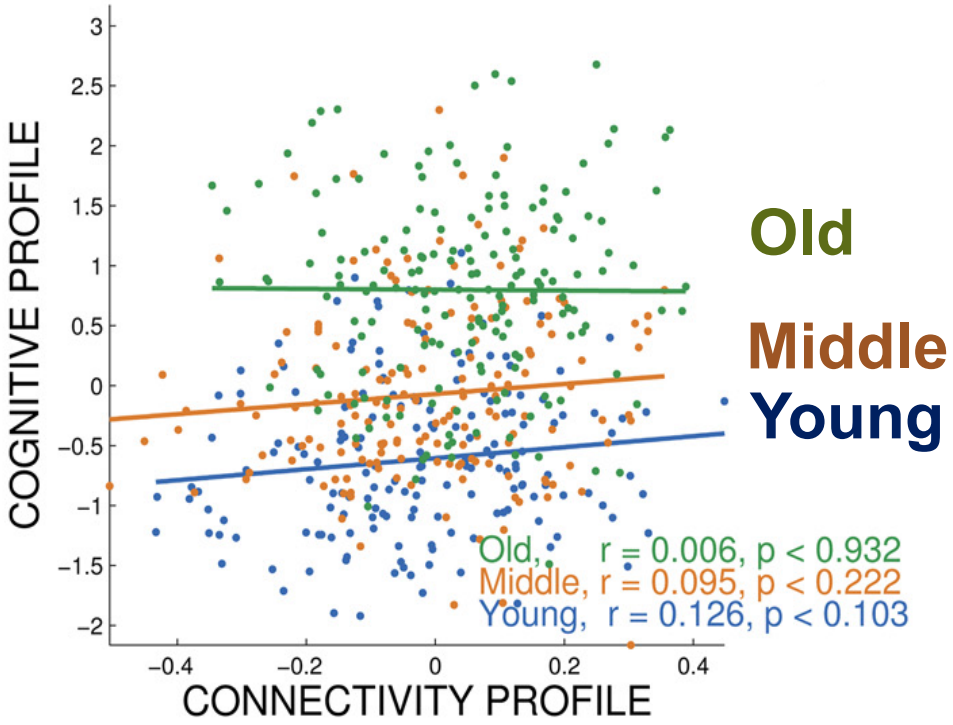
Functional Connectivity (Pearson)

Canonical Correlation Analysis (CCA):





Tsvetanov et al (2016) Journal of Neuroscience

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Vascular Conclusions

- Many age-related fMRI (de)activations are likely to reflect vascular rather than neural changes…

  Tsevtanov et al (2015), Hum. Brain. Mapping

- …specifically in vasodilatory signal decay and haemodynamic transit time (though not in all brain regions, eg right motor cortex)

  Henson et al (preprint), BioRXiv

- Not just (de)activations, but even fMRI functional connectivity (FC) is influenced by vascular health…

  Geerligs et al (2017), Hum. Brain. Mapping

- …and once you allow for vascular contributions, relationship of (neural) FC with cognition gets stronger…

  Tsvetanov et al (2016), Journal of Neuroscience

- So if you want to study age effects on fMRI, either:
  - Adjust data by RSFA, mean FC, or independent vascular measures (BP, ECG)…
  - …or separate neural and vascular components with a model (eg DCM)
  - …or use an non-haemodynamic measure, eg MEG…

    Price et al (2016), Nat Comms…

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Outline

- Vascular changes (fMRI+MEG)
- Latency effects (MEG+DTI)
- Effects of APO-E (sMRI+fMRI+MEG)
- Cognitive Reserve (sMRI+fMRI)

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Sensory Evoked Responses in MEG

nature COMMUNICATIONS

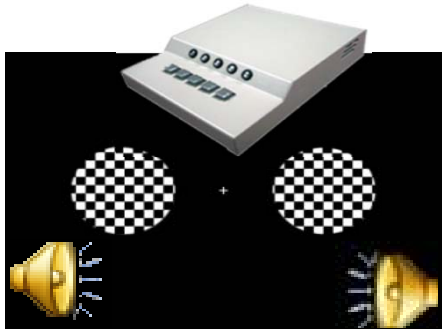
ARTICLE

Received 24 May 2016 | Accepted 18 Apr 2017 | Published 9 Jun 2017

DOI: 10.1038/ncomms15671 OPEN

Age-related delay in visual and auditory evoked responses is mediated by white- and grey-matter differences

D. Price[1], L.K. Tyler[2], R. Neto Henriques[1], K.L. Campbell[3], N. Williams[4], M.S. Treder[2], J.R. Taylor[5], Cam-CAN[†] & R.N.A. Henson[1]



Darren Price

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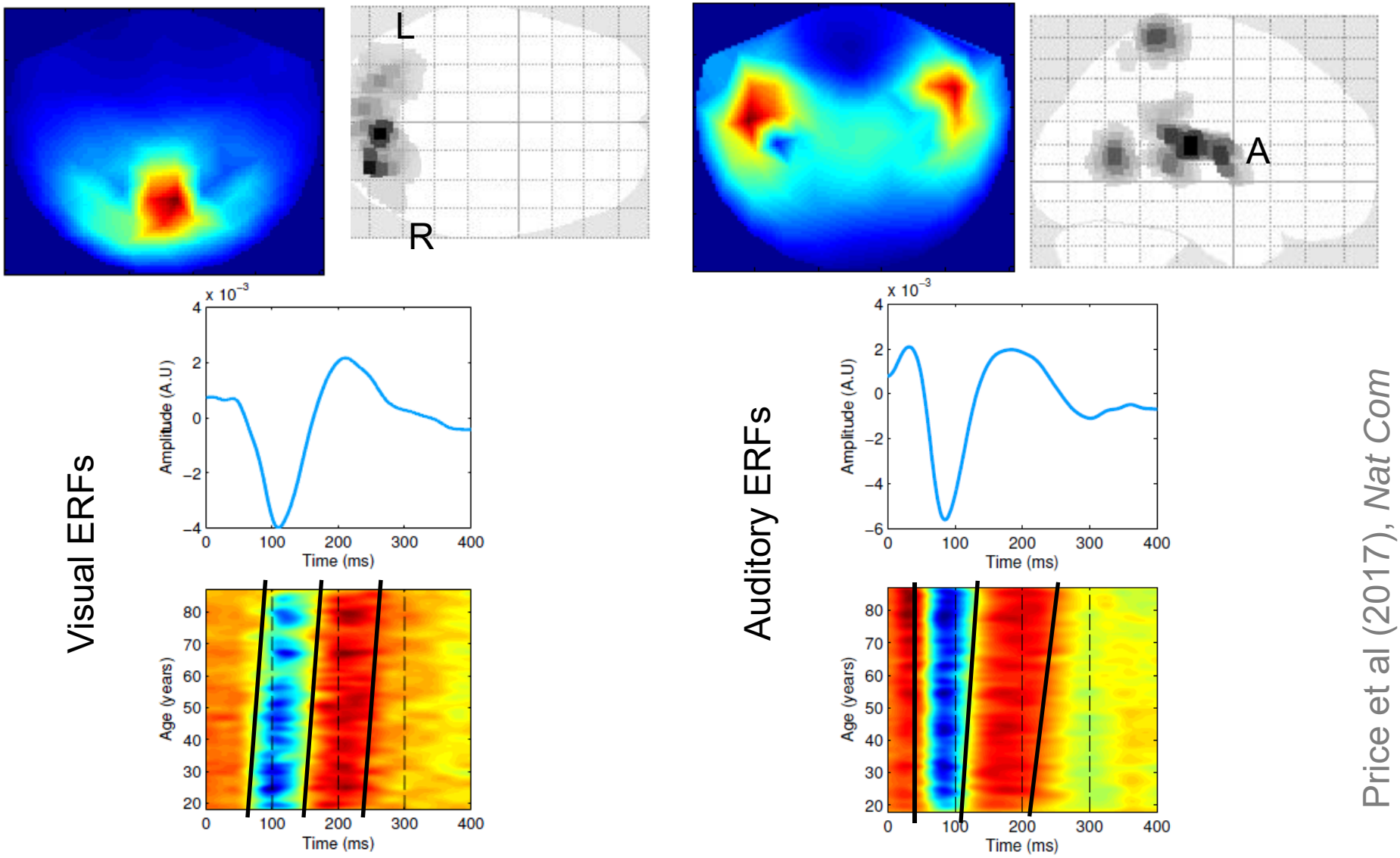
Sensory Evoked Responses in MEG



Price et al (2017), *Nat Com*

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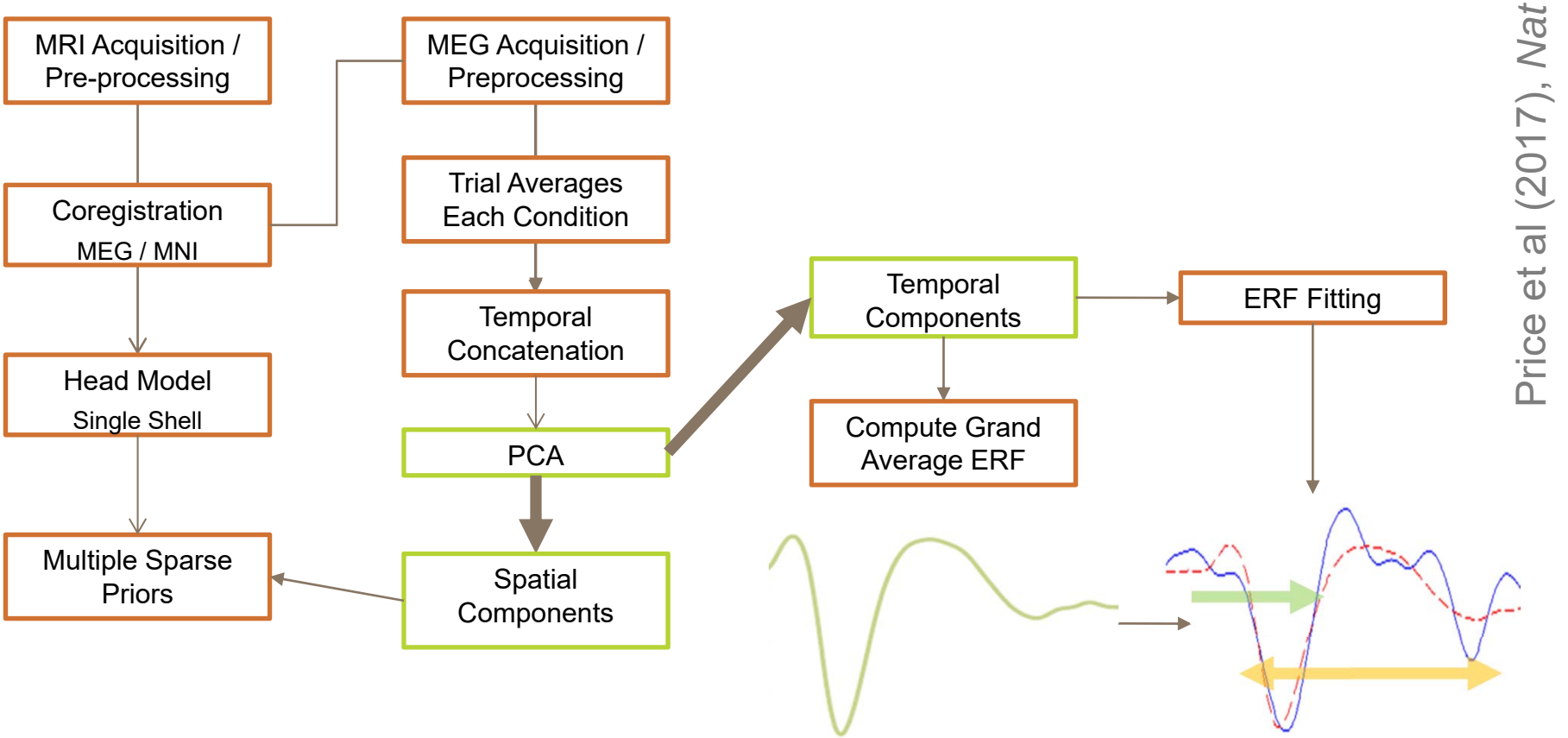
Analysis



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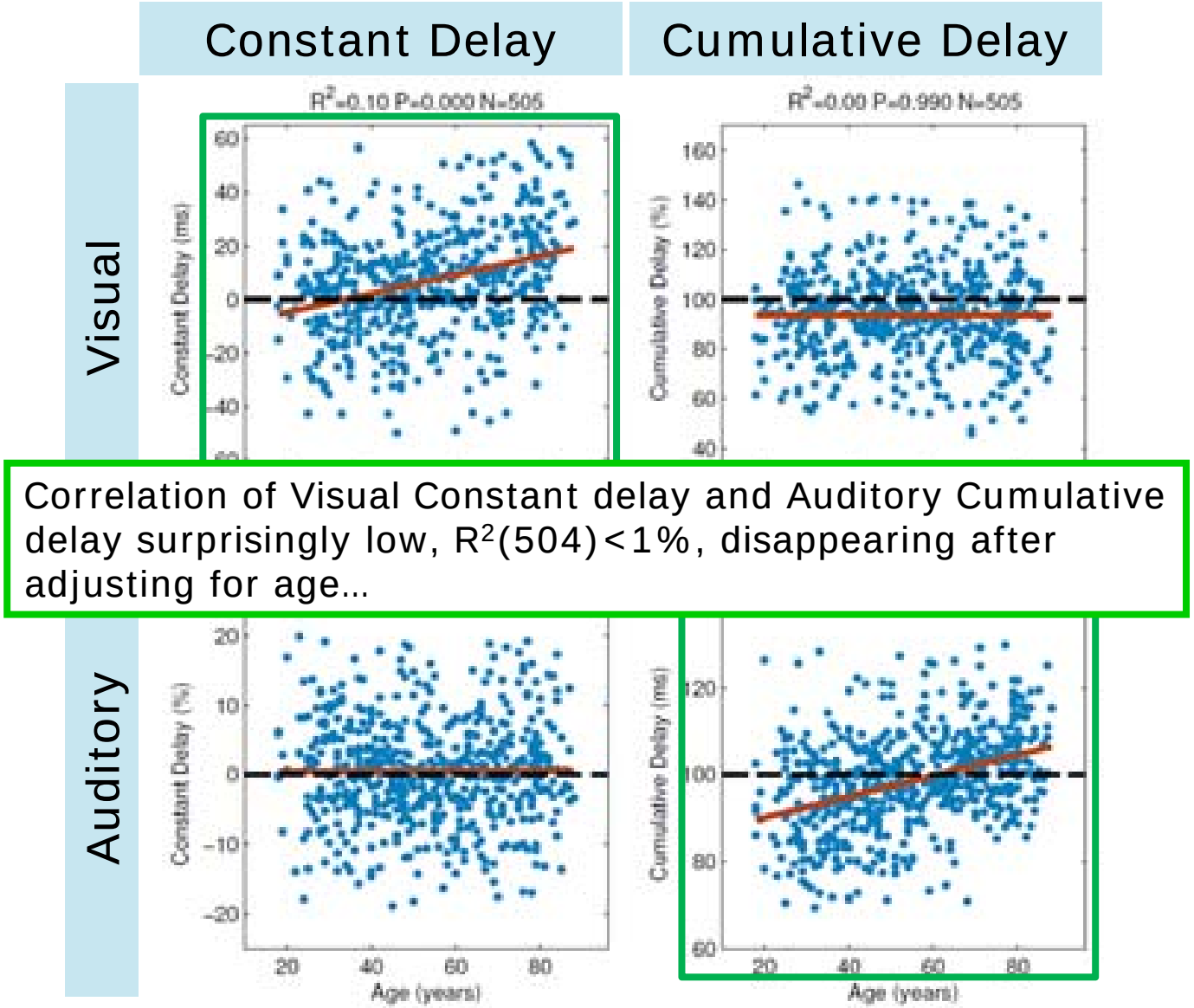
Sensory Evoked Responses in MEG



Correlation of Visual Constant delay and Auditory Cumulative delay surprisingly low, $R^2(504)<1\%$, disappearing after adjusting for age…

Price et al (2017), *Nat Com*

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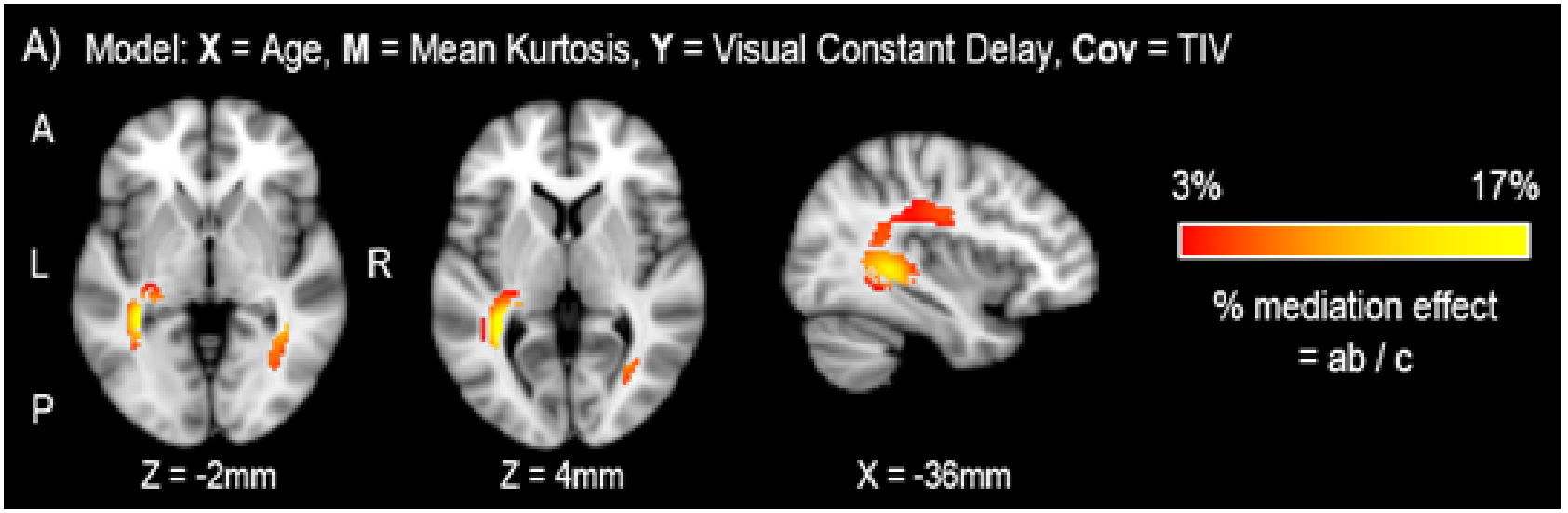
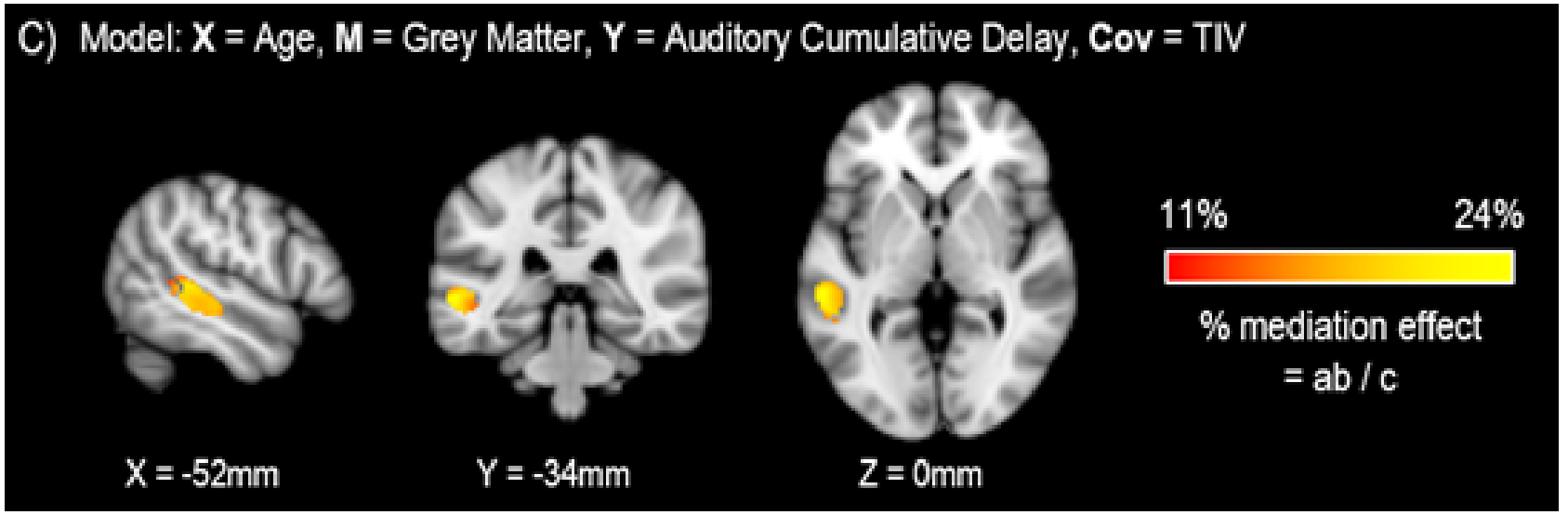
Voxel-wise Mediation





Price et al (2017), *Nat Com*

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Sensory Evoked Responses in MEG

- Age exerts differential and uncorrelated effects on visual evoked latency (constant delay) and auditory evoked latency (cumulative delay)

- White Matter integrity (MK) in optic radiation mediates effect of Age on Visual Constant delay

  – delayed transmission?

- Grey-Matter Volume (GMV) within auditory cortex mediates effect of Age on Auditory Cumulative delay

  – local computation?

- MEG reveals multiple contributions to age-related neural slowing

Price et al (2017), *Nature Communications*

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Outline

- Vascular changes (fMRI+MEG)
- Latency effects (MEG+DTI)
- Effects of APO-E (sMRI+fMRI+MEG)
- Cognitive Reserve (sMRI+fMRI)

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Genetics

Brain and Neuroscience Advances

Registered Report

Brain and Neuroscience Advances
Volume 4: 1–12

DOI: 10.1177/2398212820961704
journals.sagepub.com/home/bna
SAGE

Effect of apolipoprotein E polymorphism on cognition and brain in the Cambridge Centre for Ageing and Neuroscience cohort

Richard N. Henson[1,2], Sana Suri[3,4], Ethan Knights[1], James B. Rowe[1,5], Rogier A. Kievit[1], Donald M. Lyall[6], Dennis Chan[7], Else Eising[8] and Simon E. Fisher[8,9]

Henson et al (2020) Brain Neuro Advances

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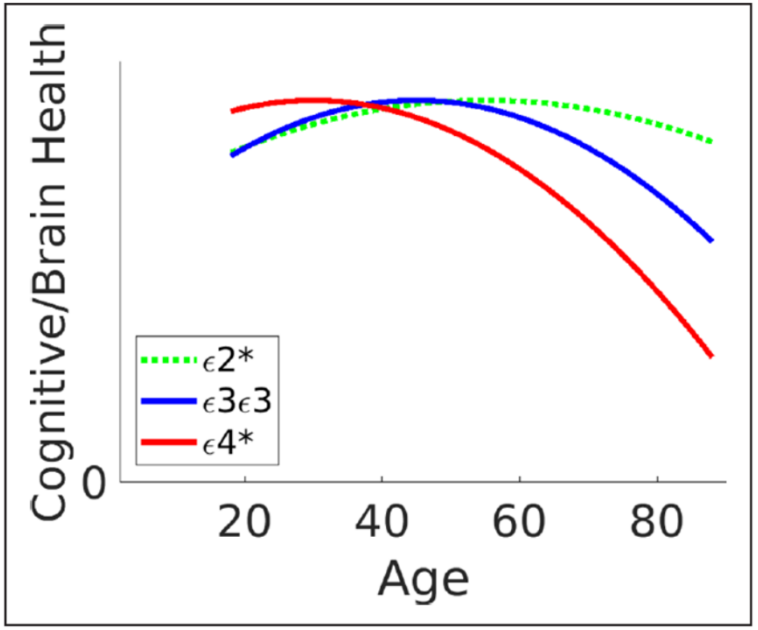
Genetics

- Presence of an e4 allele (relative to more common e3) in APOE gene is associated with cognitive decline in old age, specifically Alzheimer's Disease

- The "Antagonistic Pleiotropy" hypothesis claims that e4 offers benefits earlier in life (which could contribute to its prevalence in population)

- The e2 polymorphism, on other hand, is claimed to be neuroprotective in old age



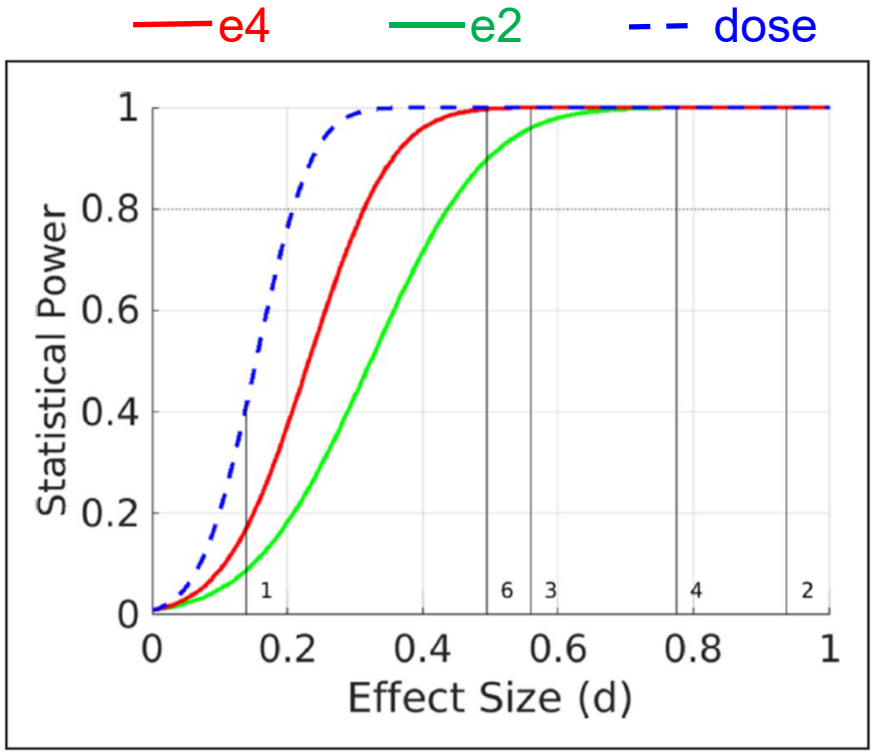
Henson et al (2020) Brain Neuro Advances

Genetics

- We published a Registered Report (i.e., APOE status de-blinded after acceptance) to test Antagonistic Pleiotropy hypothesis, in terms of a (quadratic) Age X APOE interaction

- We tested interaction on 6 outcomes:
  1. Fluid Intelligence
  2. Episodic Memory
  3. Hippocampal Volume
  4. White Matter FA
  5. DMN FC from fMRI
  6. FC from MEG

- Though small N for genetic study (N~600), prior APOE effect sizes so large that should be detectable



Henson et al (2020) Brain Neuro Advances

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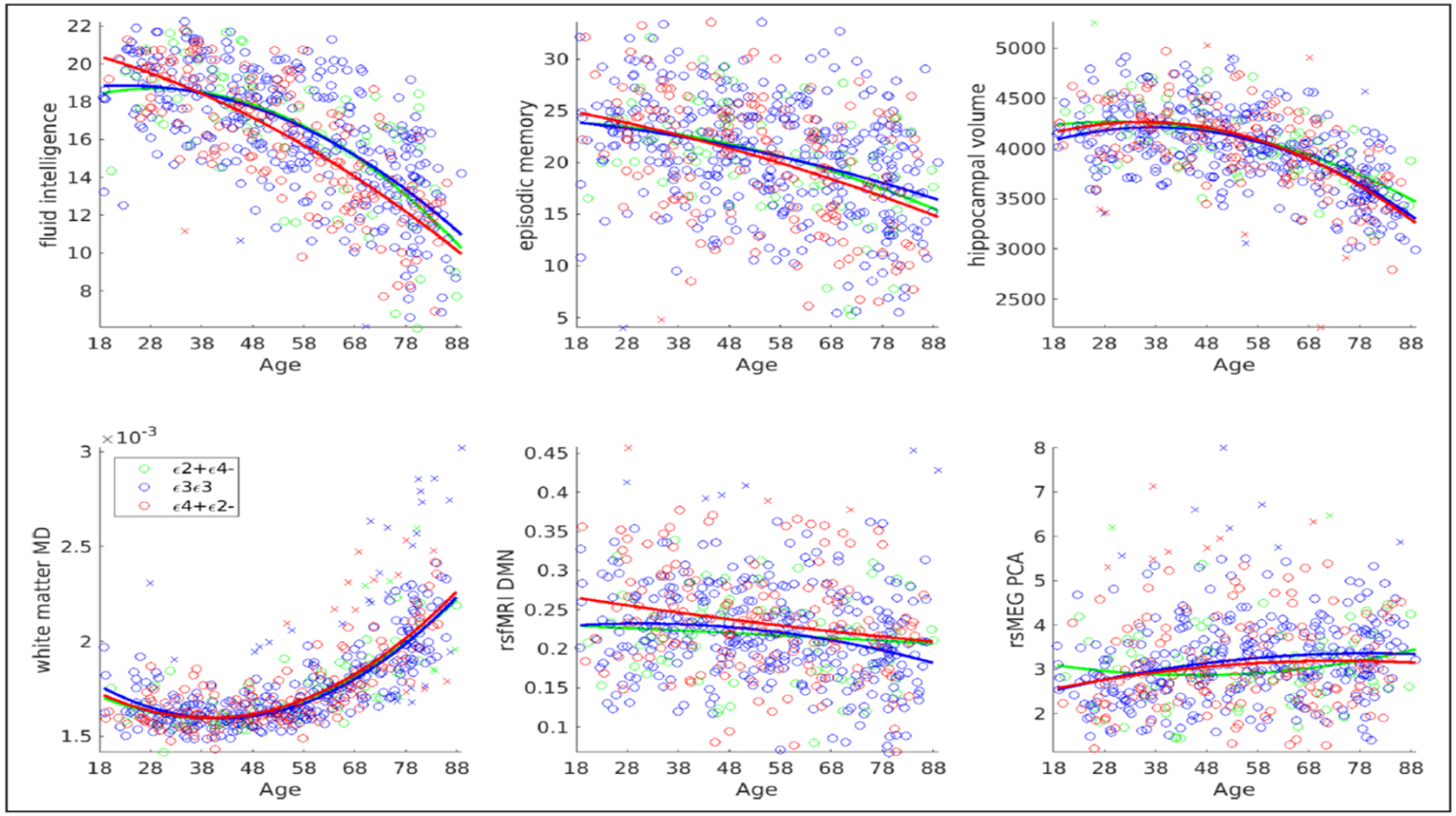
Genetics



- In no case was there a significant Age-by-APOE interaction for either e4 or e2 (or dose effect), and Bayes Factors favoured the null…

  … i.e,. evidence **against** the Antagonistic Pleiotropy hypothesis

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Outline

- Vascular changes (fMRI+MEG)
- Latency effects (MEG+DTI)
- Effects of APO-E (sMRI+fMRI+MEG)
- Cognitive Reserve (sMRI+fMRI)

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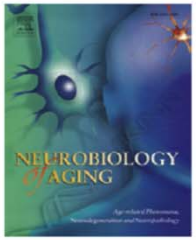
Cognitive Reserve

Neurobiology of Aging 70 (2018) 180–183

Contents lists available at ScienceDirect

Neurobiology of Aging

journal homepage: www.elsevier.com/locate/neuaging



Brief communication

Lifestyle activities in mid-life contribute to cognitive reserve in late-life, independent of education, occupation, and late-life activities

Check for updates

Dennis Chan [a,*], Meredith Shafto [b], Rogier Kievit [b], Fiona Matthews [c], Molly Spink [b], Michael Valenzuela [d,e], Cam-CAN, Rik N. Henson [b]

Dennis Chan

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Cognitive Reserve

- Cognitive Reserve (CR) is used to explain why some people maintain cognitive health despite brain changes owing to, e.g, ageing and dementia (Stern, 2002).
- One factor commonly associated with CR is level of education.
- Here, we explore more *modifiable* factors, such as mid-life activities.
- Identifying such factors will enable public health strategies for maintaining cognitive health in old age and dementia (Gow et al., 2017).

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LEQ and Cognitive Data

- We analysed data from the “Lifetime Experience Questionnaire” (LEQ; Valenzuela & Sachdev, 2007)
- N=205 population-derived healthy individuals >65 years of age in CC700 phase of CamCAN
- We defined Cognitive Health by the Cattell test of fluid intelligence (similar results obtained when taking the first principal component across 12 more specialised cognitive tests.)

Chan et al (2018) Neurobiology of Aging

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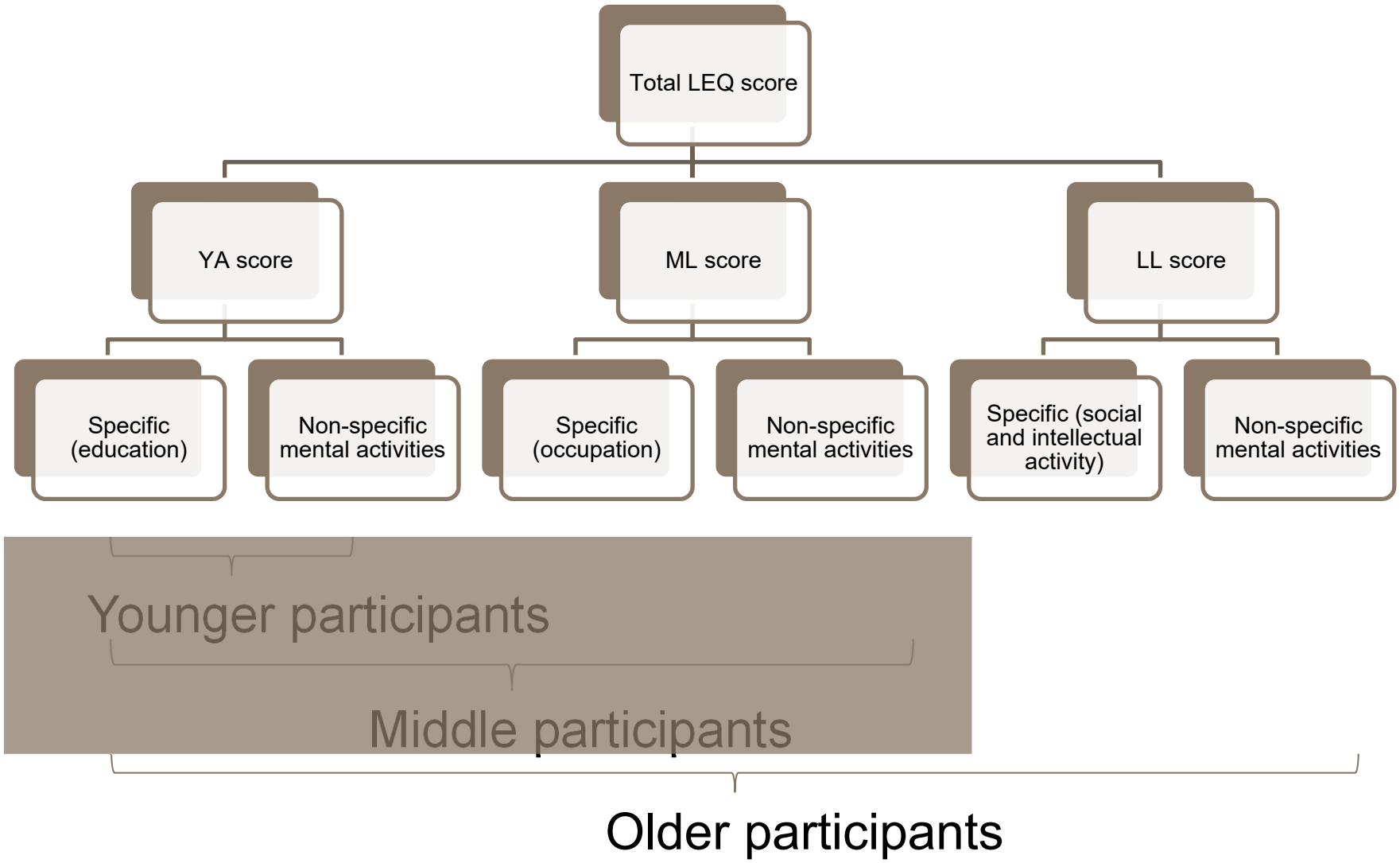
LEQ



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LEQ

6 LEQ Variables		
Young Adult (18-29)	Specific	**Education** (national careers service, level multiplied by number of years)
	Non-specific	Eg family outings, musical instrument, physical activity, board games
Mid-Life (30-65)	Specific	**Occupation** (standard occupational scores, multiplied by number of years)
	Non-specific	Eg family outings, musical instrument, physical activity, board games
Late-Life (66-88)	Specific	**Other roles** (social, charity, family, etc, summed score)
	Non-specific	Eg family outings, musical instrument, physical activity, board games

Chan et al (2018) Neurobiology of Aging

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LEQ->Cognition

- (All LEQ scores positively related to Cognition in separate regressions)
- **Multiple** linear regression of the LEQ scores, together with age and sex, revealed unique contributions of:

Variable	Normalised Coefficient	Percentage Variance	P-value (df=196)
Young Adult Specific	+0.259	6.70	3.58e-4
Young Adult Non-specific	+0.027	0.08	.723
Mid-Life Specific	+0.096	0.93	.164
Mid-Life Non-specific	+0.324	10.50	2.53e-5
Late-Life Specific	+0.010	0.99	.110
Late-Life Non-specific	-0.098	0.96	.195
Age	-0.287	8.26	1.93e-6
Sex	-0.082	0.67	.201

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Brain Health

- While mid-life activities may help preserve cognition in old age, to qualify for Cognitive Reserve, these activities need to **moderate** the relationship between Cognition and Brain

- On n=195 individuals, Brain health was estimated from T1+T2-weighted MRIs as Total Gray Matter, adjusted for head size (aTGM)

- Tested for the interaction (moderation) between Mid-Life Non-specific Activities and aTGM in predicting Cognition

  (for visualisation purposes, split the group into High (n=103) and Low (n=92) levels of Mid-Life Non-specific activities)

Chan et al (2018) Neurobiology of Aging

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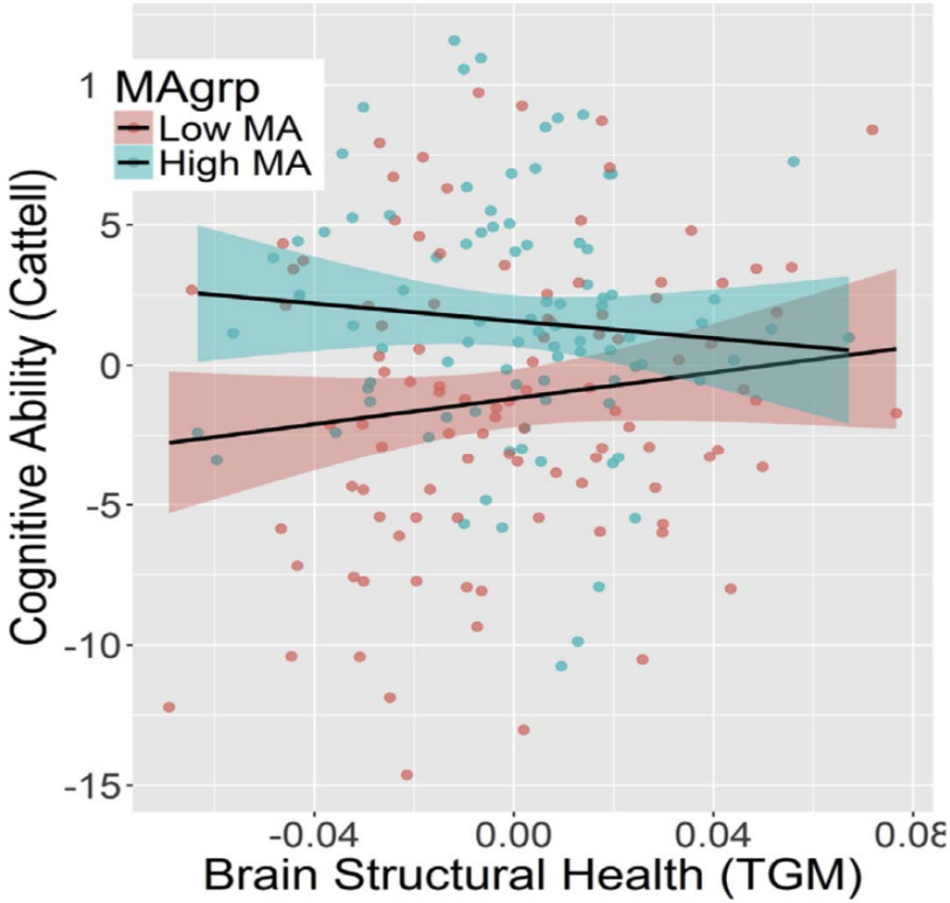
Midlife Activities moderate Brain->Cognition

- Significant linear interaction (adjusting for education, age, sex), in that Cognition was less related to (structural) Brain health when Mid-Life Nonspecific Activities were high…
- …as expected if Mid-Life activity is a form of Cognitive Reserve



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Conclusions

- We identified a type of Cognitive Reserve – Mid-Life Nonspecific activity (i.e, beyond occupation) – which:

  1) predicted Cognition years later in old age, over and above Education in youth and current activities in old age

  2) reduced the dependency of Cognition on Brain Structure

  3) is potentially modifiable by simple interventions (perhaps easier than for other determinants of Cognitive Reserve like Education)

Chan et al (2018) Neurobiology of Aging

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Caveats

- Apart from being beyond occupation, we could not distinguish whether key mid-life activities are physical, intellectual and/or social

- Warning: “reverse causation” still possible (i.e, cognition caused lifestyle):

  - Lifestyle could be influenced by past (stable) cognitive ability (no direct childhood measure of cognition like Gow et al, 2017)
    - Though childhood cognition likely to correlate with education?

  - Lifestyle Reporting could be affected by current cognitive ability
    - Though autobiographical memory not severely affected in healthy ageing?

- Prospective studies, with *objective* measures of mid-life physical / social / intellectual activity will need to replicate in future…

(which is why longitudinal cohorts are vital, and need funding, eg CamCAN…)

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Caveats

- But Cognitive Reserve must have some brain correlate (even if not Brain Structure)…. what about Brain Function?

- Functional segregation of large-scale networks may be key….

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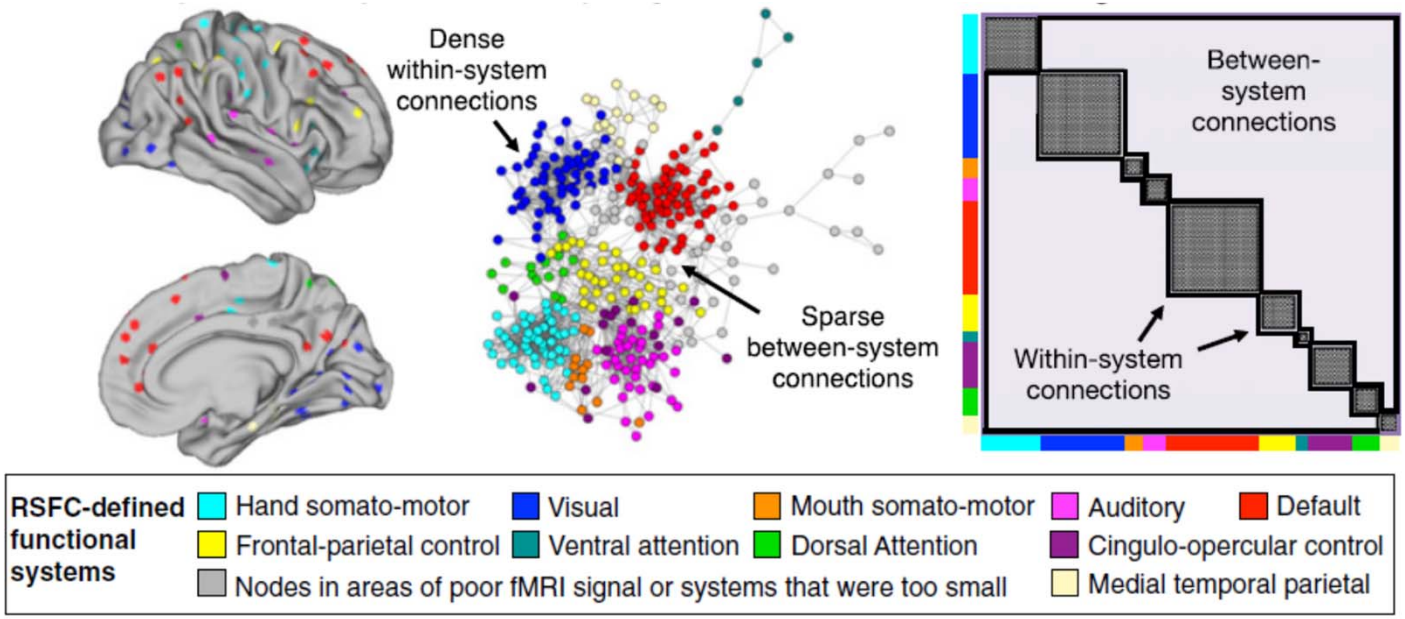
(Functional) Systems Segregation (SyS)

- Functional connectivity can be measured while recording brain activity during rest, leading to a number of large-scale “networks”
- Functional segregation refers to how well those networks are separated (within-network minus between-network connectivity)



Reproduced from Chan et al (2018) | PNAS | vol. 115 | no. 22 | E5144–E5153

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(Functional) Systems Segregation (SyS)

PsyArXiv Preprints

My Preprints Submit a Preprint

Does functional system segregation mediate the effects of lifestyle on cognition in older adults?

AUTHORS

Petar Raykov, Ethan Knights, Richard Henson

AUTHOR ASSERTIONS

Conflict of Interest: No ▾ Public Data: Available ▾ Preregistration: Available ▾

Petar Raykov

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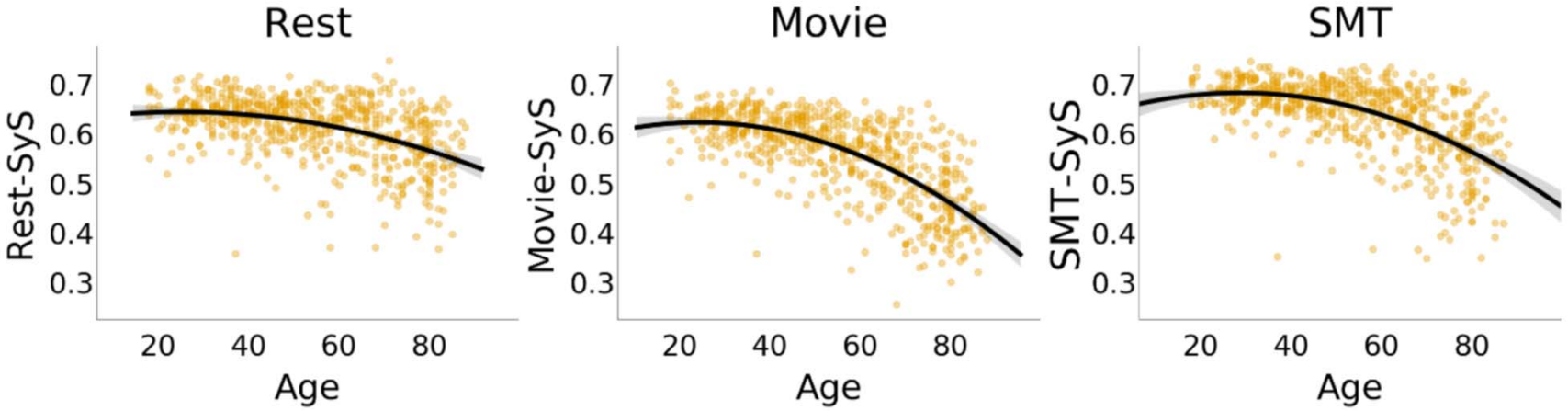
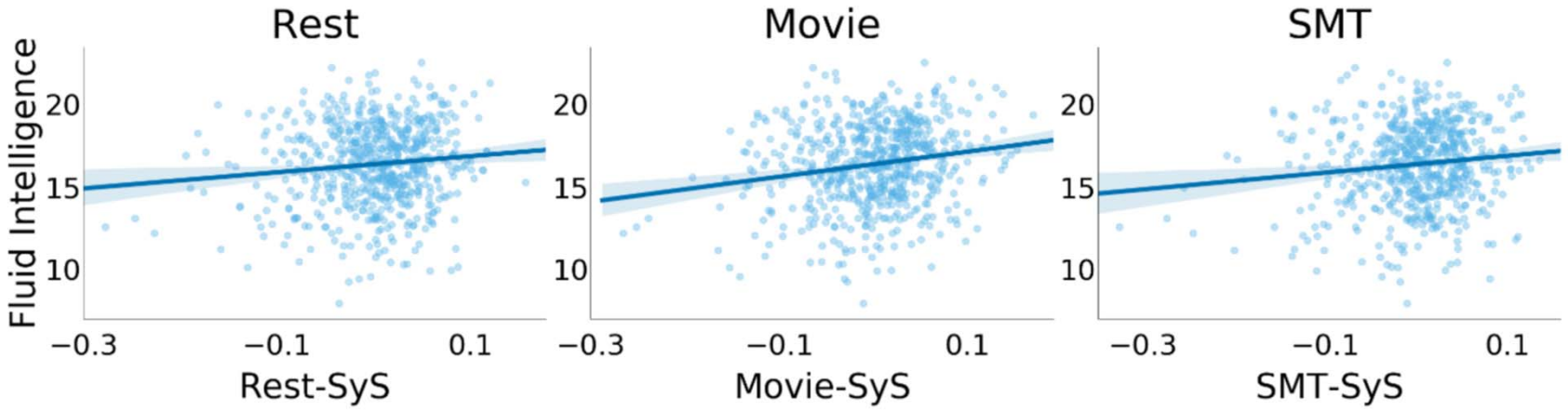
Functional (System) Segregation (SyS)

- Functional (System) Segregation (SyS) certainly declines with age…
  (even after adjusting for vascular health)…



- …and is related to fluid intelligence (Cattell) even after adjusted for (second-order) effects of age:



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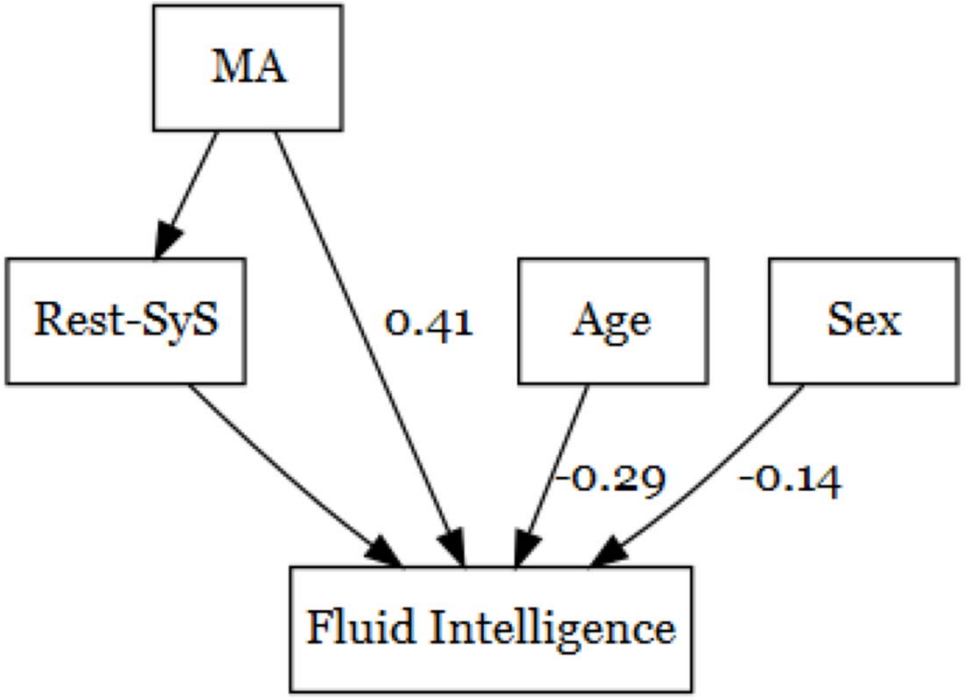
(Functional) Systems Segregation (SyS)



- SyS does not **mediate** effect of mid-life activities (MA) on cognition
  (simply does not relate to MA in either old-age or across whole adult lifespan)

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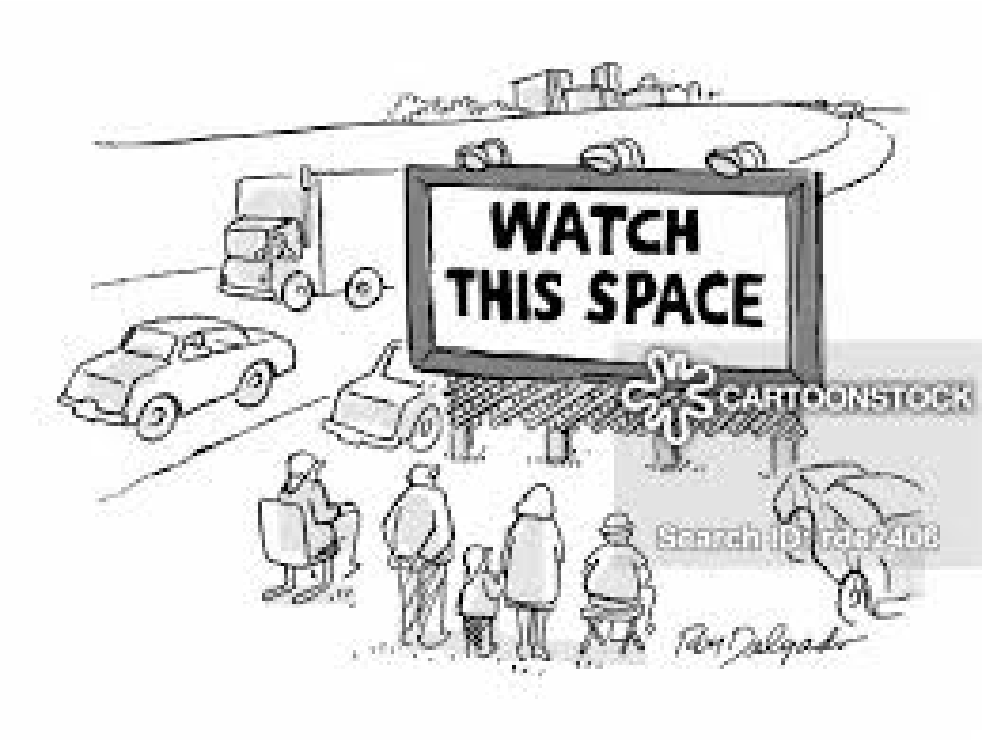
(Functional) Systems Segregation (SyS)

- Functional segregation declines rapidly with age, and is related to fluid intelligence even after adjusting for age…
- …but doesn't relate to mid-life activities

- So what is neural correlate of cognitive reserve? White matter health…?



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