#OHBM2022
@JoramSoch

Abstract #2600
Poster #MT738
Talk in Oral Session

Structural and functional MRI data differentially predict chronological age and memory performance

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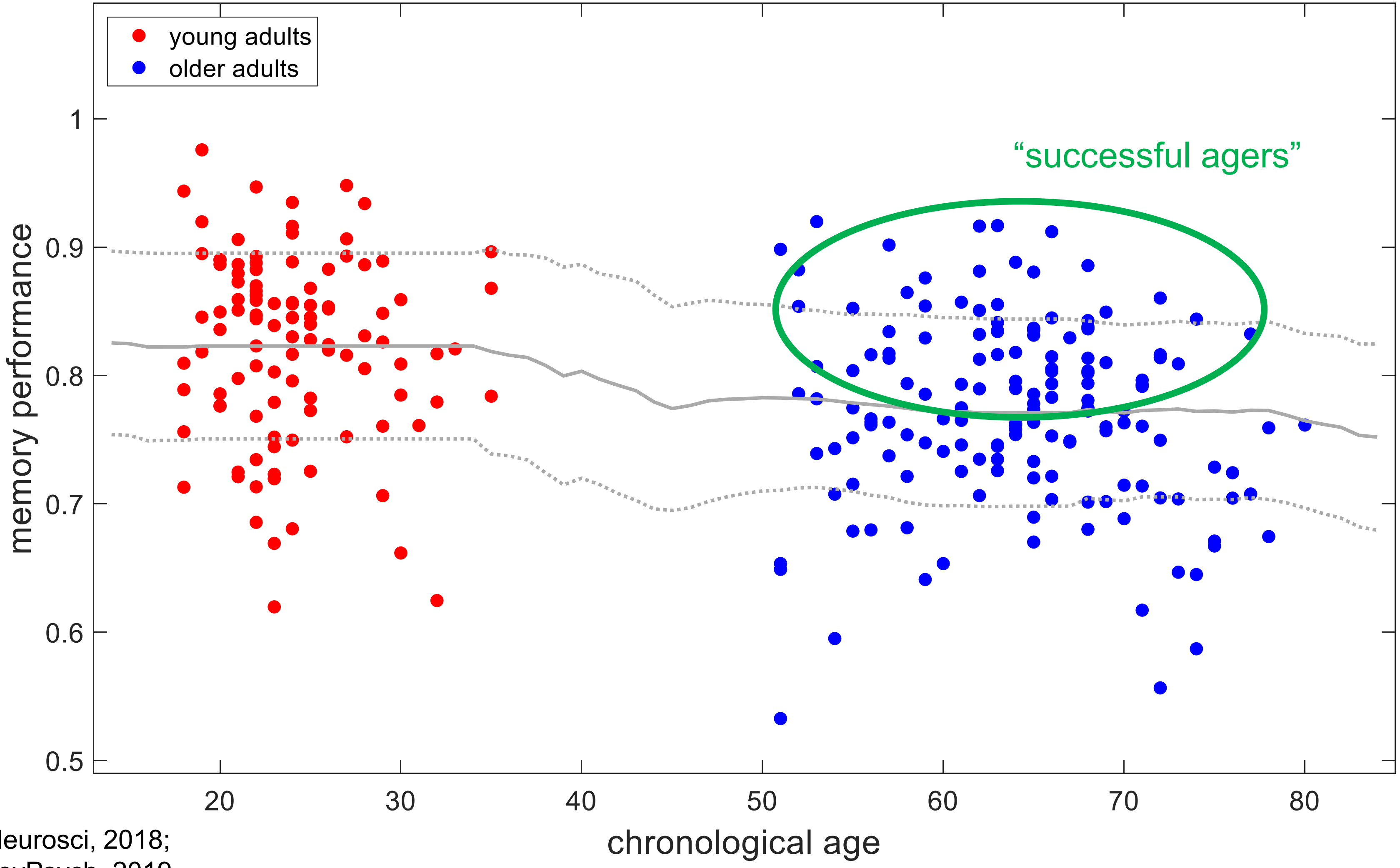
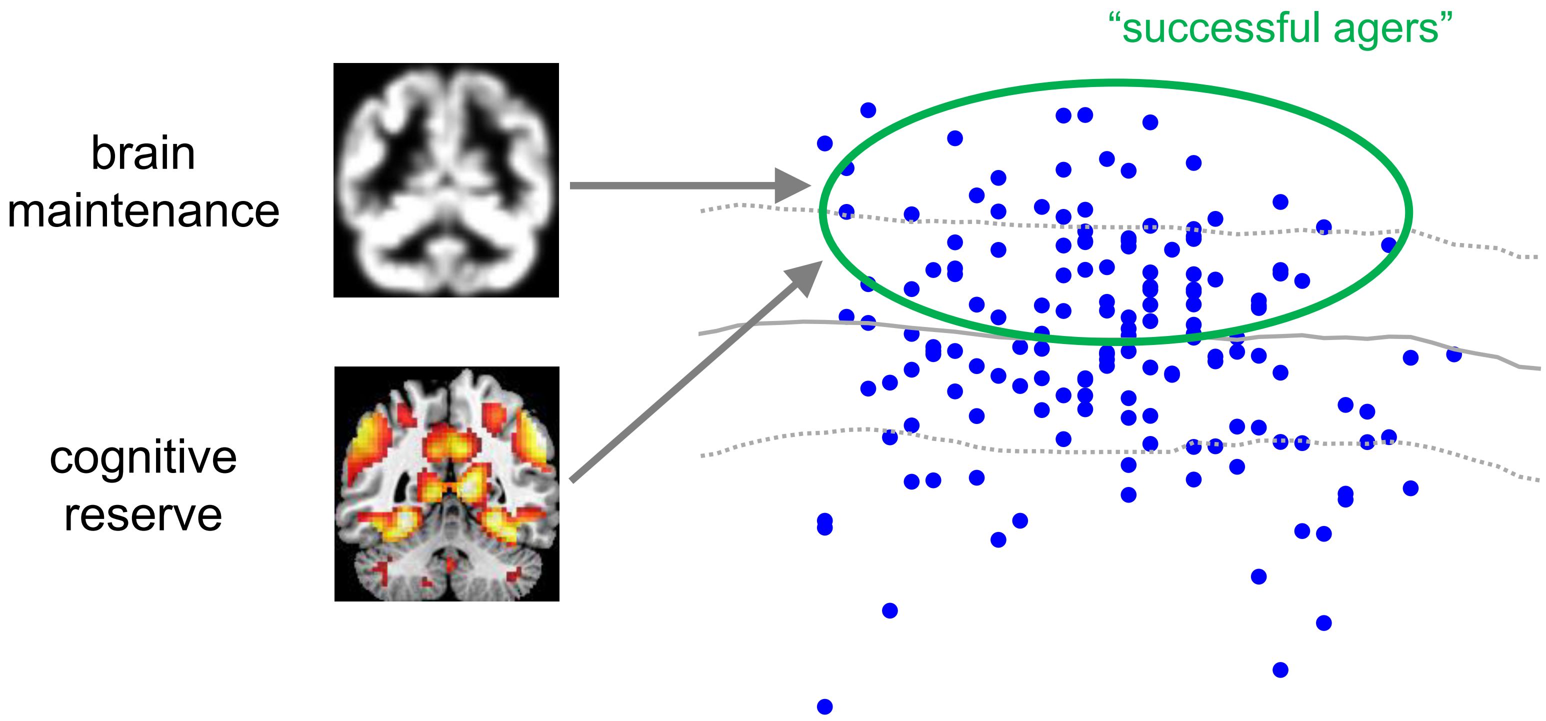
Although cognitive performance declines with increasing age, some older adults show memory comparable to young subjects.



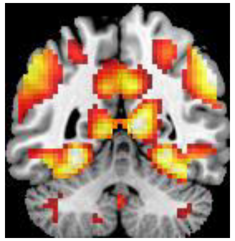
Cabeza et al., NatRevNeurosci, 2018;
Nyberg & Pudas, AnnRevPsych, 2019.

It is an open question whether this is due to preserved structure or functional compensation.



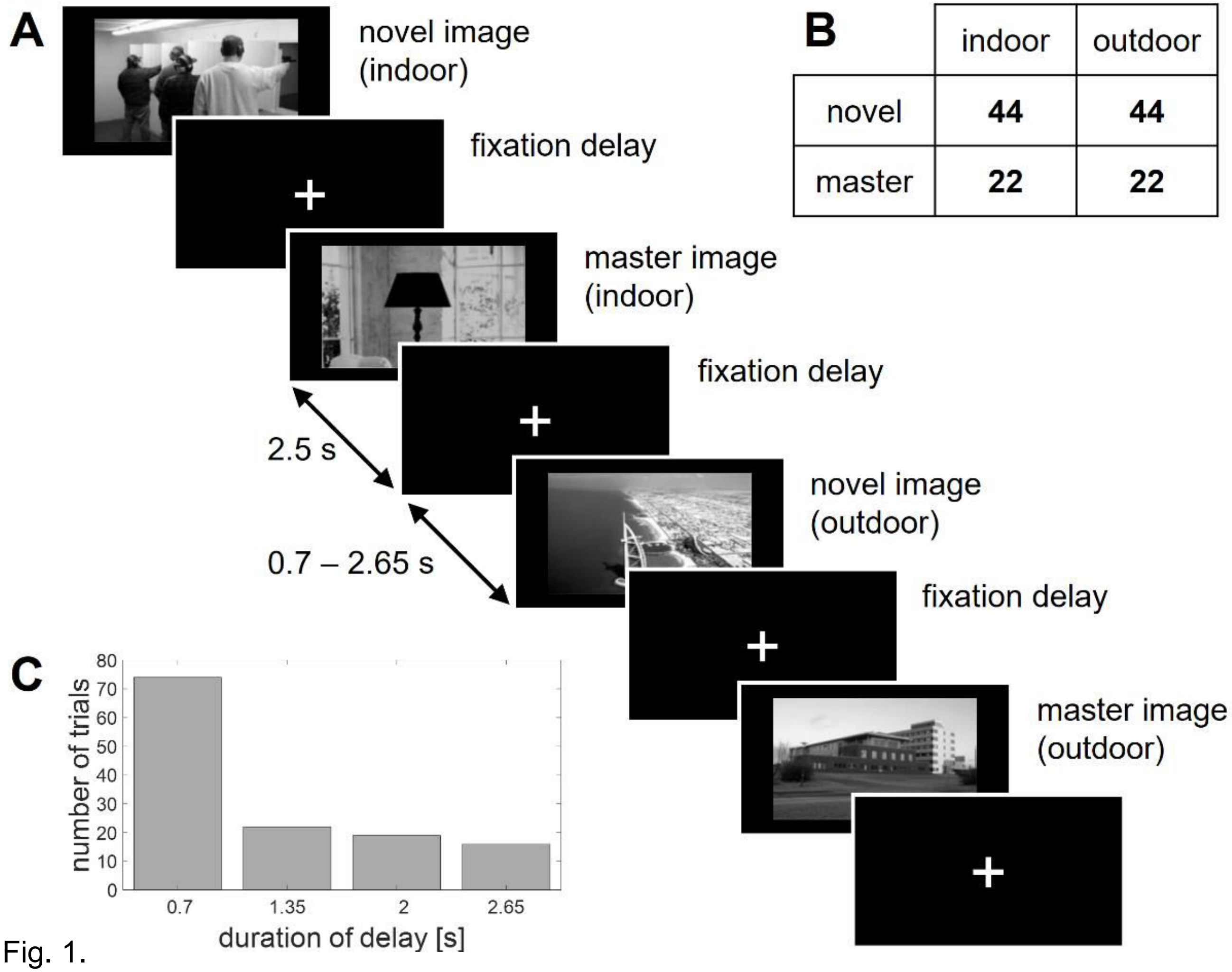
Cabeza et al., OUP, 2004; Nyberg et al., TICS, 2012; Cabeza et al., NatRevNeurosci, 2018; Nyberg & Pudas, AnnRevPsych, 2019.

Different hypotheses about successful aging make different predictions about memory performance correlates.

Theory of successful aging		Differences in memory should concur with …
brain maintenance		… differences in structural MRI patterns.
cognitive reserve		… differences in functional MRI responses.

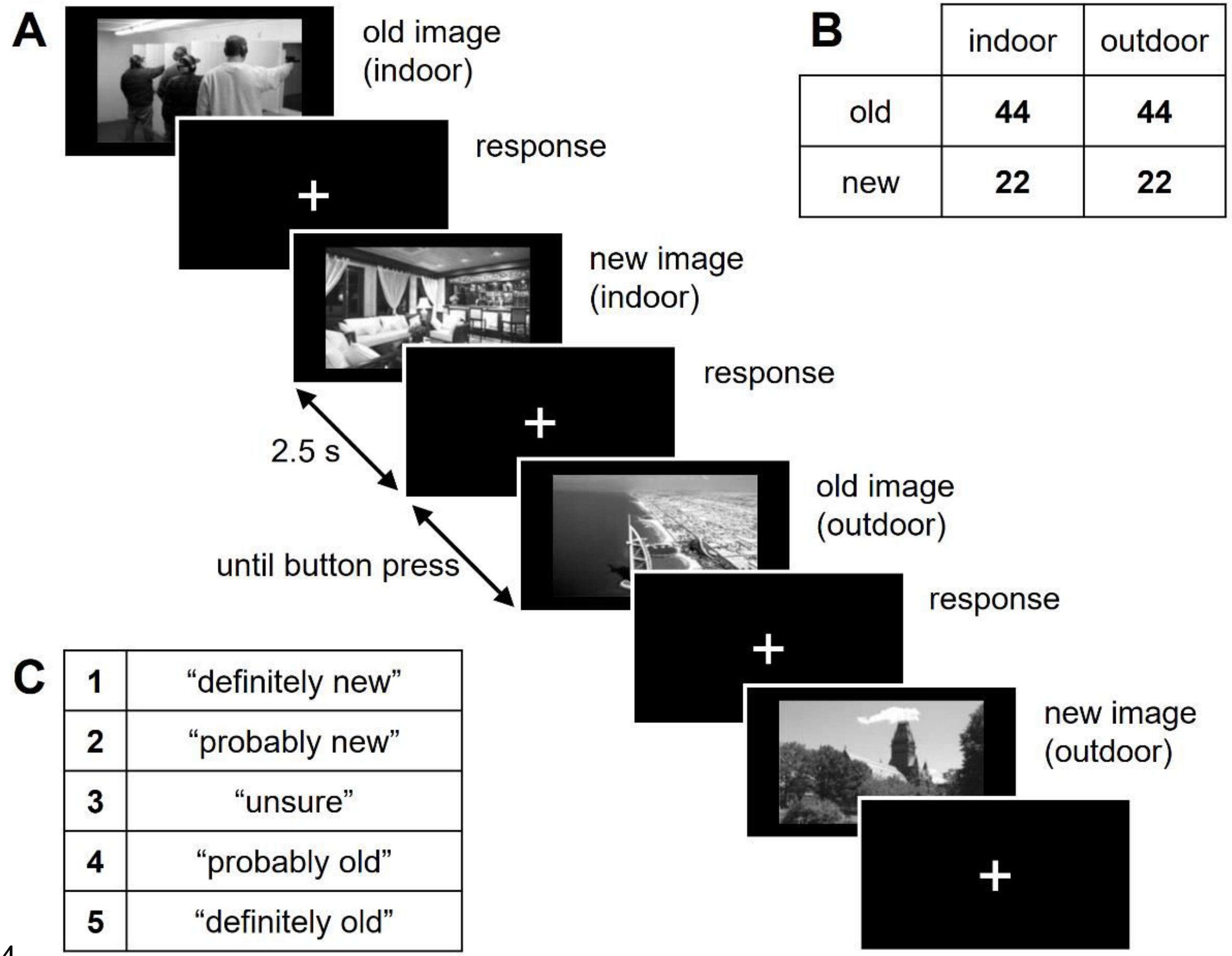
Cabeza et al., OUP, 2004; Nyberg et al., TICS, 2012; Cabeza et al., NatRevNeurosci, 2018; Nyberg & Pudas, AnnRevPsych, 2019.

We measured brain activity of young and older subjects while they were seeing novel vs. pre-familiarized (master) images.



Soch*, Richter* et al., NeuImg, 2021, Fig. 1.

In a subsequent memory test, subjects were shown all old and some new images and provided a memory judgement.



B

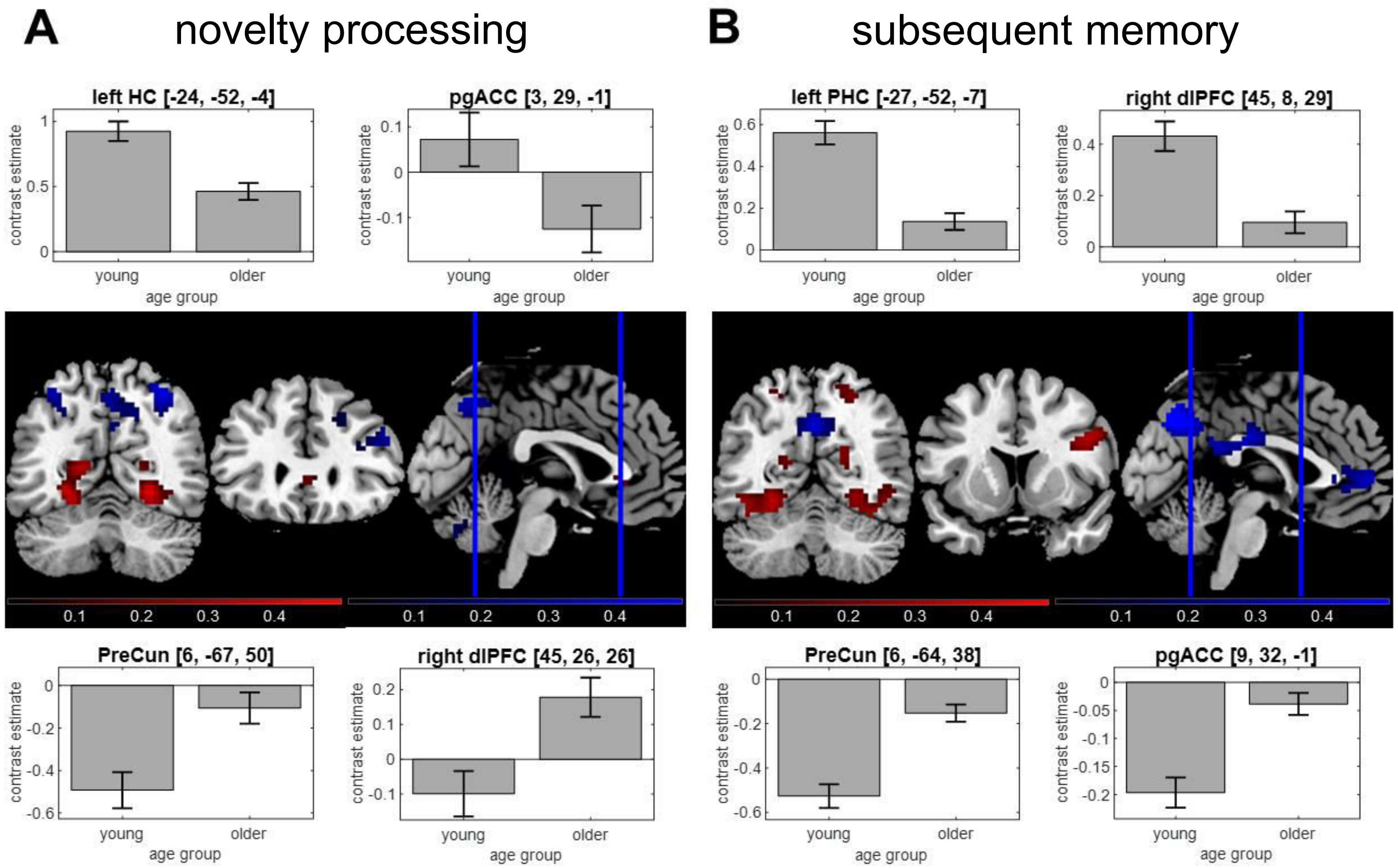
	indoor	outdoor
old	**44**	**44**
new	**22**	**22**

C

1	“definitely new”
2	“probably new”
3	“unsure”
4	“probably old”
5	“definitely old”

Soch*, Richter* et al., HBM, 2021, p. 4.

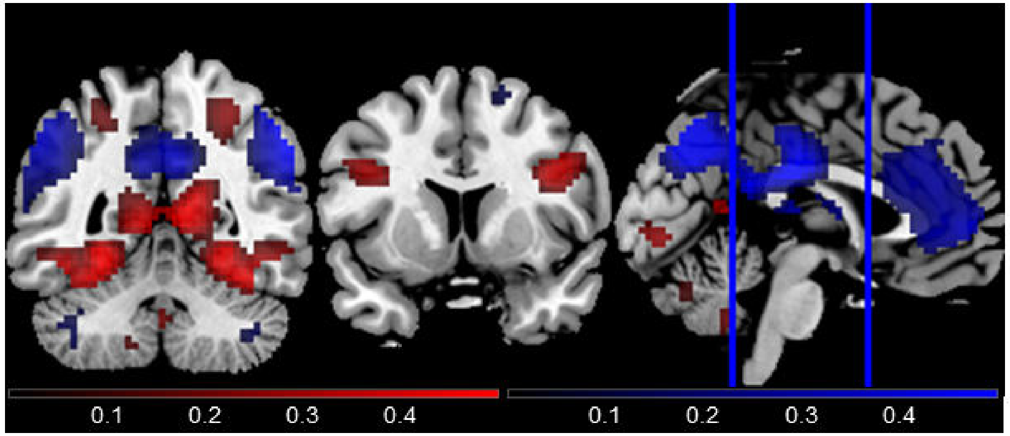
This allows to infer on fMRI activity differences with respect to novelty processing and subsequent memory.



Soch*, Richter* et al., HBM, 2021, Fig. 2.

From these fMRI contrasts, we calculated single-value scores indicating similarity with activations of young subjects.

A



i, j index subject and voxel, respectively

$\hat{\beta}_j$ mean β of young subjects in j-th voxel

$\hat{\sigma}_j$ SD of β of young subjects in j-th voxel

J_+ set of voxels in which $\beta_j > 0$ significantly

J_- set of voxels in which $\beta_j < 0$ significantly

B

$$\mathrm{FADE}_i = \frac{1}{v} \sum_{j \notin J_+} t_{ij} - \frac{1}{v_+} \sum_{j \in J_+} t_{ij}$$

$$\mathrm{SAME}_i = \frac{1}{v_+} \sum_{j \in J_+} \frac{\hat{\gamma}_{ij} - \hat{\beta}_j}{\hat{\sigma}_j} + \frac{1}{v_-} \sum_{j \in J_-} \frac{\hat{\beta}_j - \hat{\gamma}_{ij}}{\hat{\sigma}_j}$$

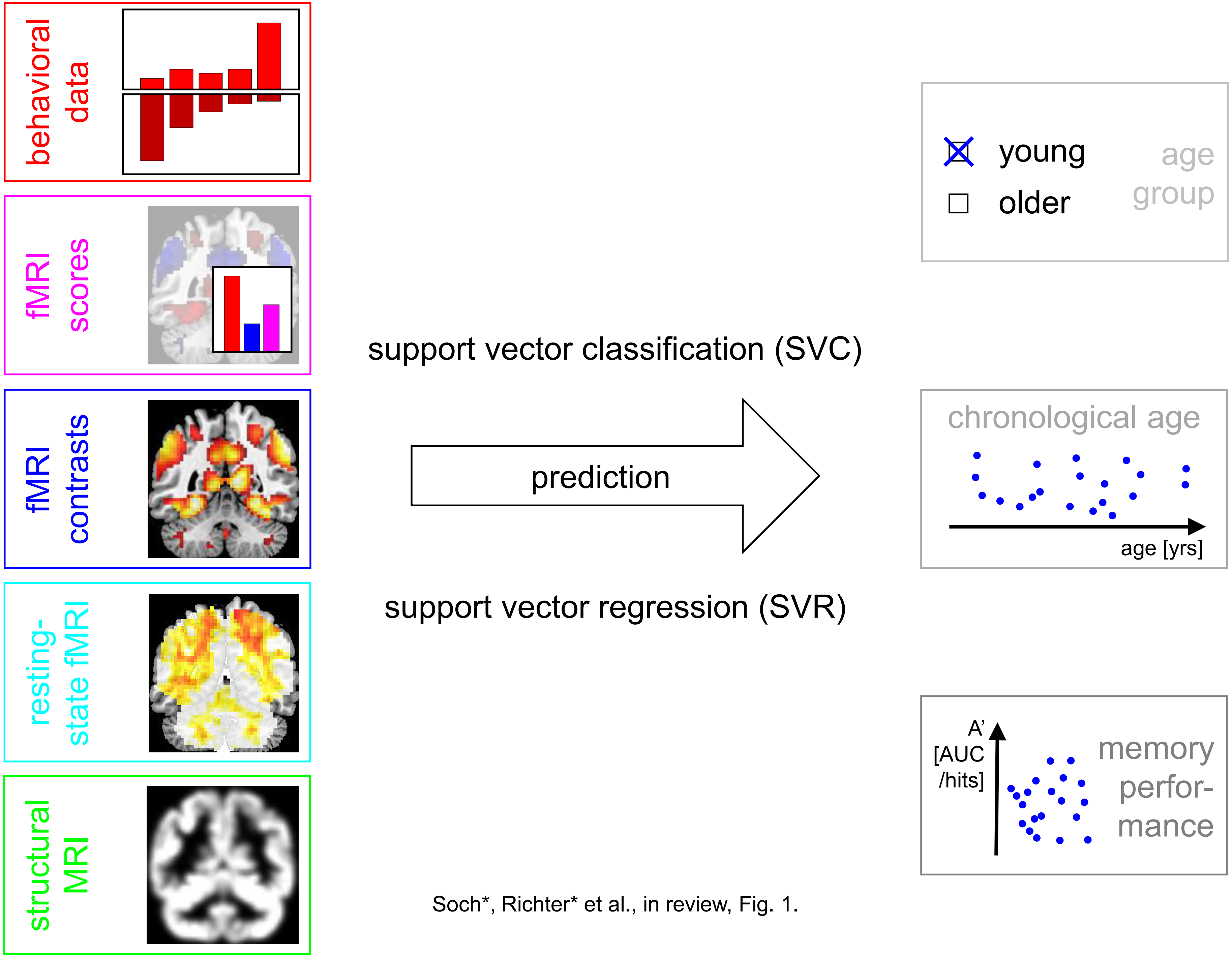
t_{ij} t-value of i-th subject in j-th voxel

v, v_+ number of voxels outside/inside J_+

$\hat{\gamma}_{ij}$ β-value of i-th subject in j-th voxel

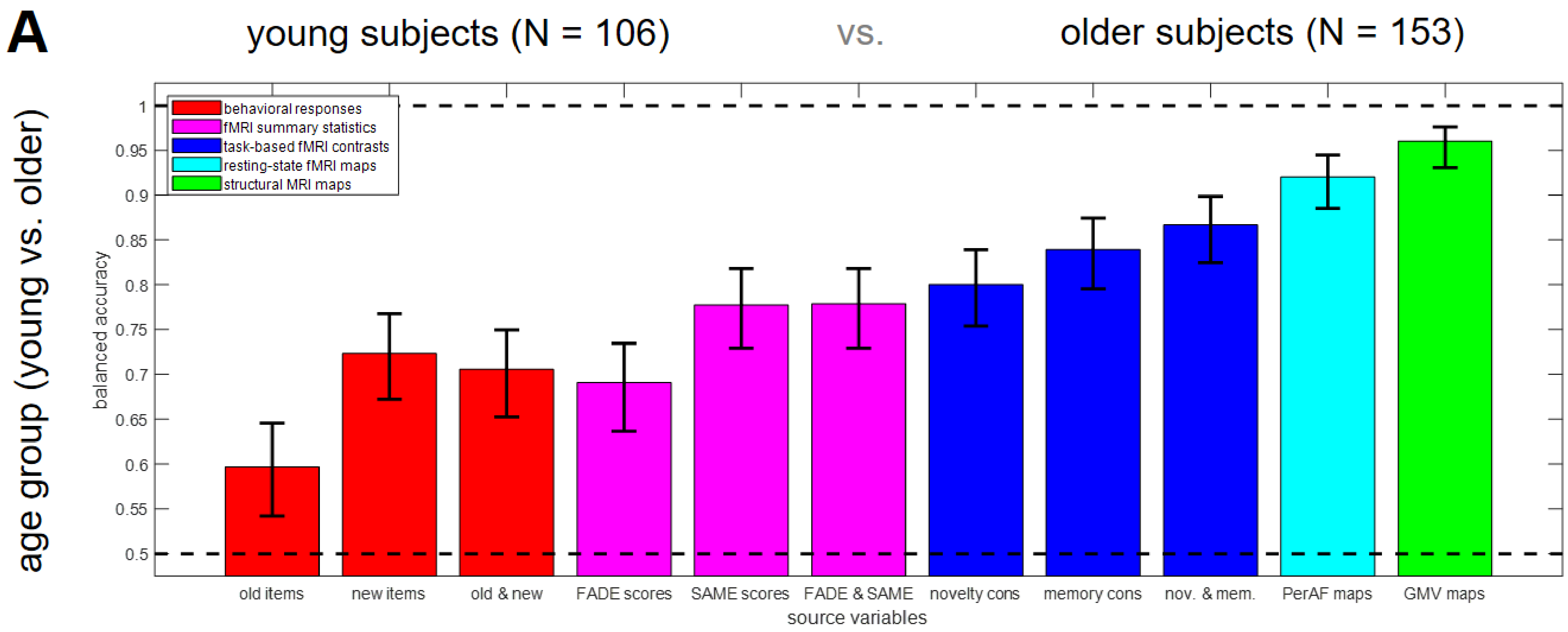
v_+, v_- number of voxels inside J_+ / J_-

Soch*, Richter* et al., HBM, 2021, Fig. 1.



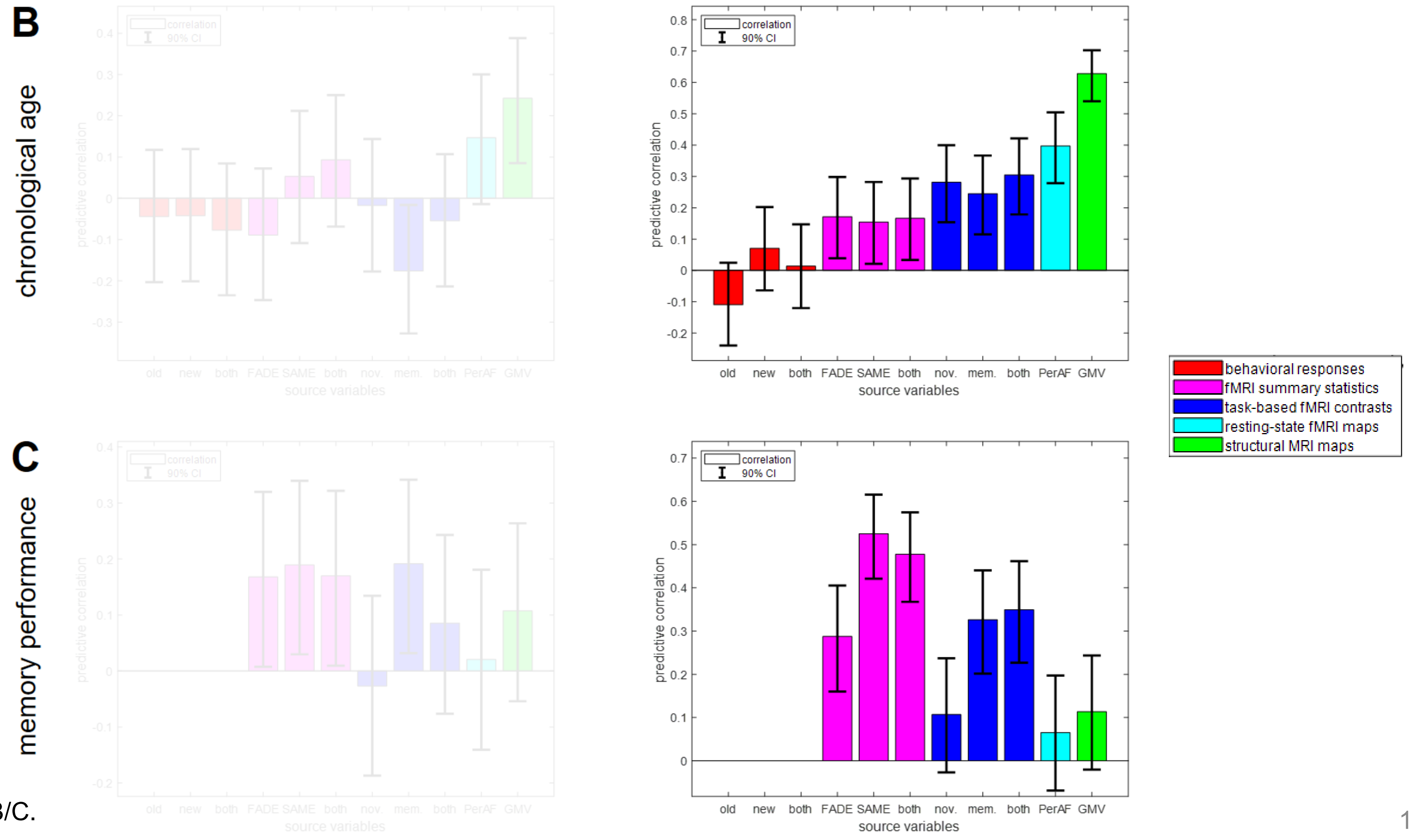
Soch*, Richter* et al., in review, Fig. 1.

Age group can be classified based on all these variables.



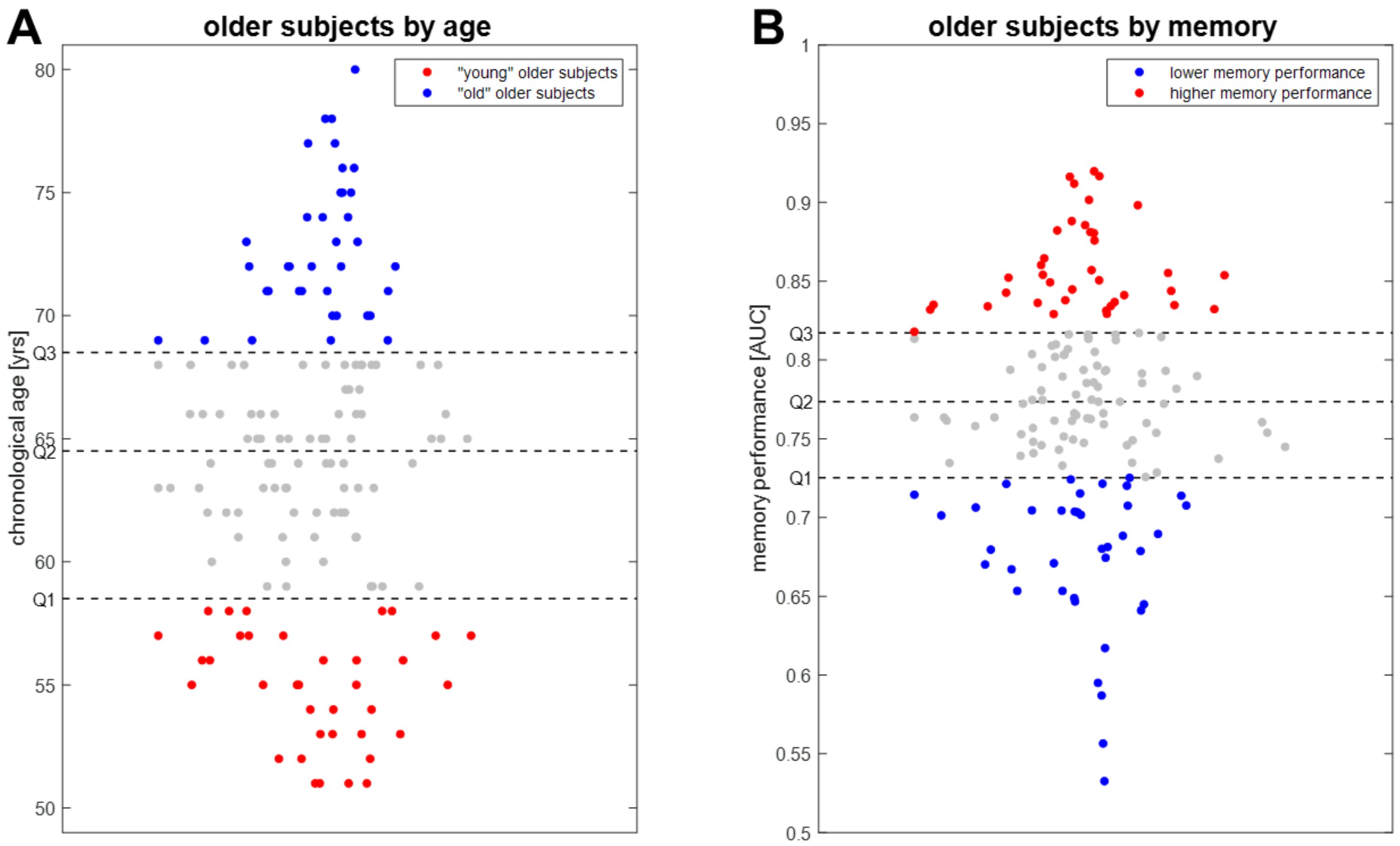
Soch et al., OHBM, 2022, Fig. 1A.

Chronological age is best predicted from structural MRI, but memory performance is best predicted from functional MRI.



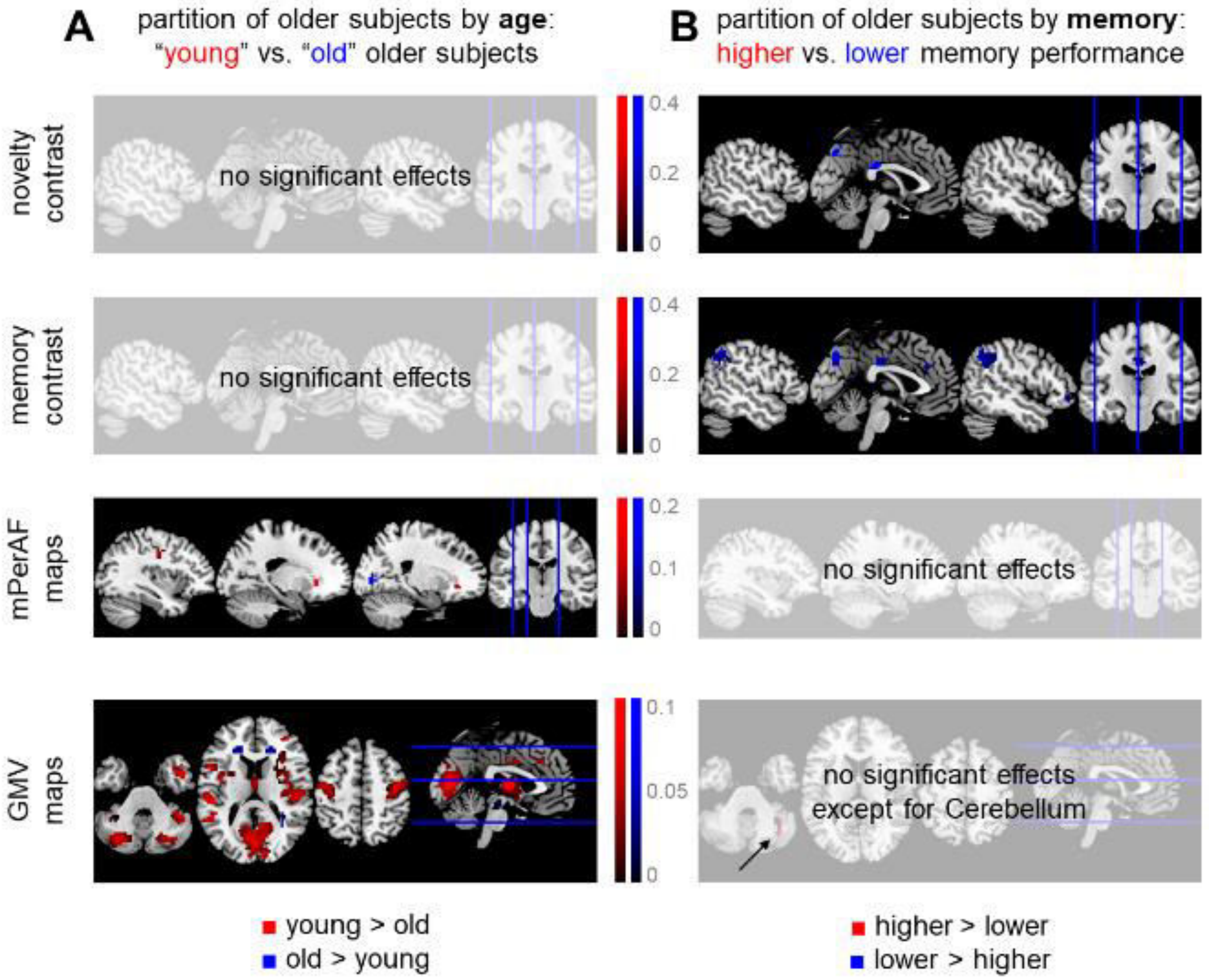
Soch et al., OHBM, 2022, Fig. 1B/C.

In order to follow up, we partitioned older subjects based on chronological age and memory performance.



Soch*, Richter* et al., in review, Fig. S3.

There is a double dissociation between memory vs. age and functional MRI vs. structural MRI (& rs-fMRI)

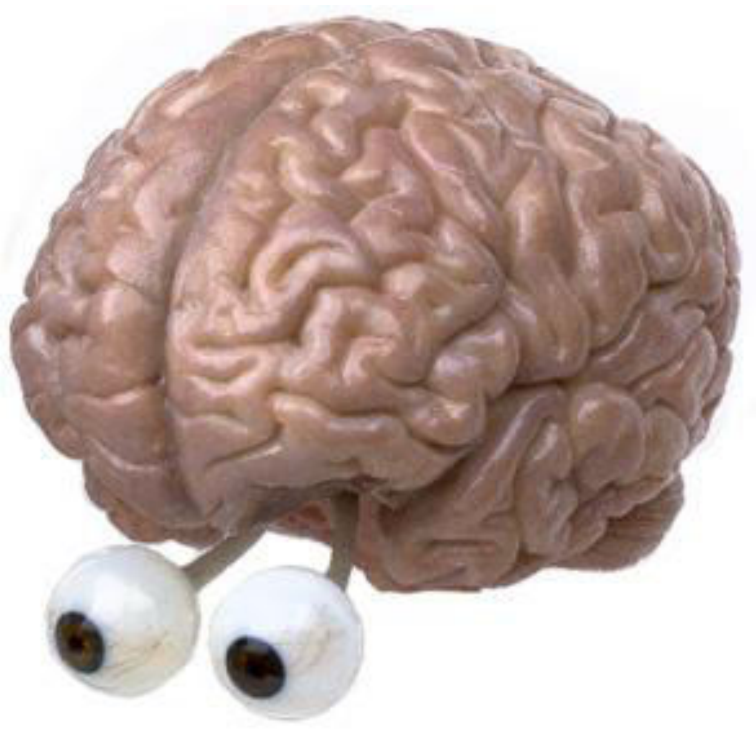


Soch*, Richter* et al., in review, Fig. 5.

Summary

- Chronological age is best predicted from structural MRI, but memory performance is best predicted from functional MRI.
- Single-value fMRI scores outperform whole-brain fMRI contrasts in predicting (independent) memory performance.
- Successful aging in memory is more likely due to efficient cognitive reserve than preserved brain maintenance.

THANK YOU!
QUESTIONS?



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Introduction

Human cognitive abilities typically decline with increasing chronological age, with explicit memory performance being particularly affected [1]. In order to track such developments [2], and especially to differentiate healthy physiological from pathophysiological aging [3], predictors of this decline need to be identified.

Whereas previous studies on age-related differences have focused on just a few potential predictors, we here compared behavioral data, task-based, resting-state and structural magnetic resonance imaging (MRI) as well as functional MRI scores in terms of their ability to predict chronological age and memory performance in two large samples of young and older adults.

Analysis

Each analysis consisted in predicting one target variable from one set of source variables (see Figure 2, left):
(i) behavioral response frequencies, i.e. fractions of responses 1-5 for old vs. new items [5, tab. S2];
(ii) voxel-wise fMRI contrasts related to novelty processing and subsequent memory [5, fig. 7];
(iii) single-value fMRI scores (FADE & SAME score) computed from these contrasts [6,7];
(iv) voxel-wise mean percent of amplitude fluctuation (mPerAF), computed from resting-state fMRI scans; and
(v) voxel-wise gray matter volume (GMV), estimated with voxel-based morphometry from structural MR scans.
Target variables were predicted with support vector machines (SVM; see Figure 2, center) for classification (SVC) or regression (SVR) using a cost parameter of C = 1 and 10-fold cross-validation on subjects per group. For continuous target variables, distributional transformation (DT) [9] was applied after prediction.

Results

First, we assure that age group can be decoded from all source variables, with a clear hierarchy from behavioral

differences in GMV (see Figure 4A); and (ii) when partitioning subjects by memory performance, there are no

More Posters

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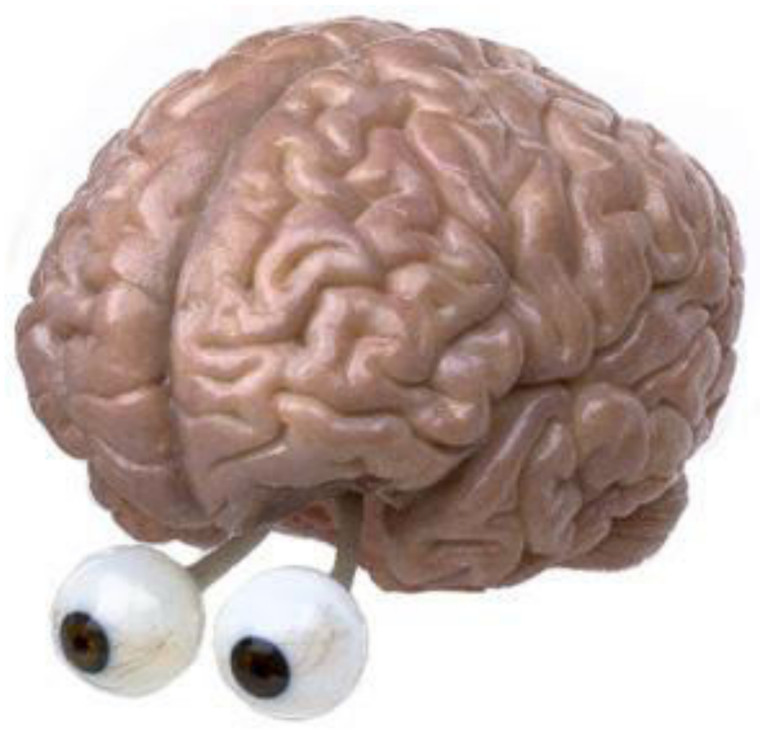
- **MT790:** Construct validity of single-value scores reflecting memory-related fMRI activity (*Anni Richter*)
- **WTh594:** Searchlight-based trial-wise fMRI decoding in the presence of trial-by-trial correlations (*Joram Soch*)

THANK YOU!
QUESTIONS?



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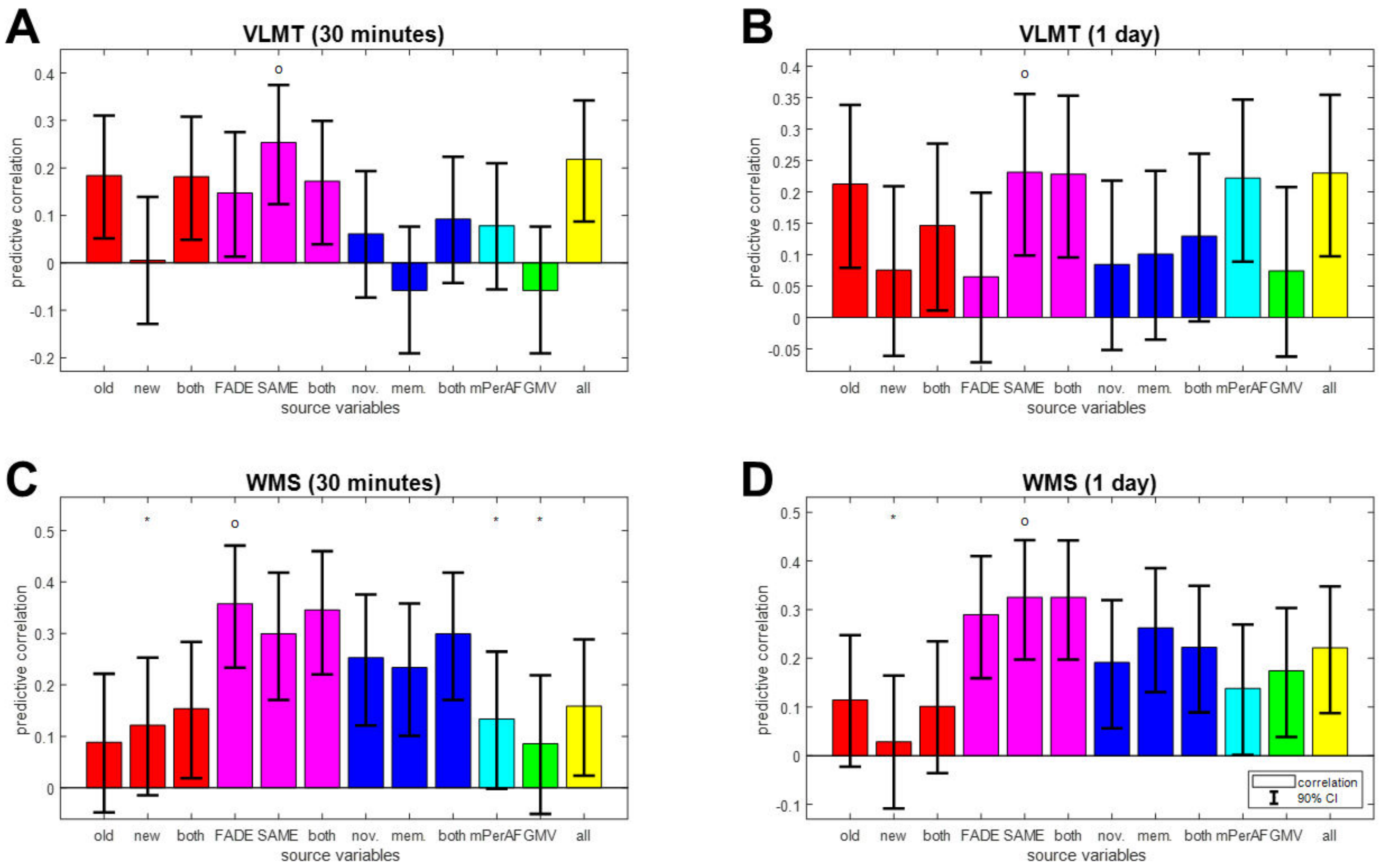
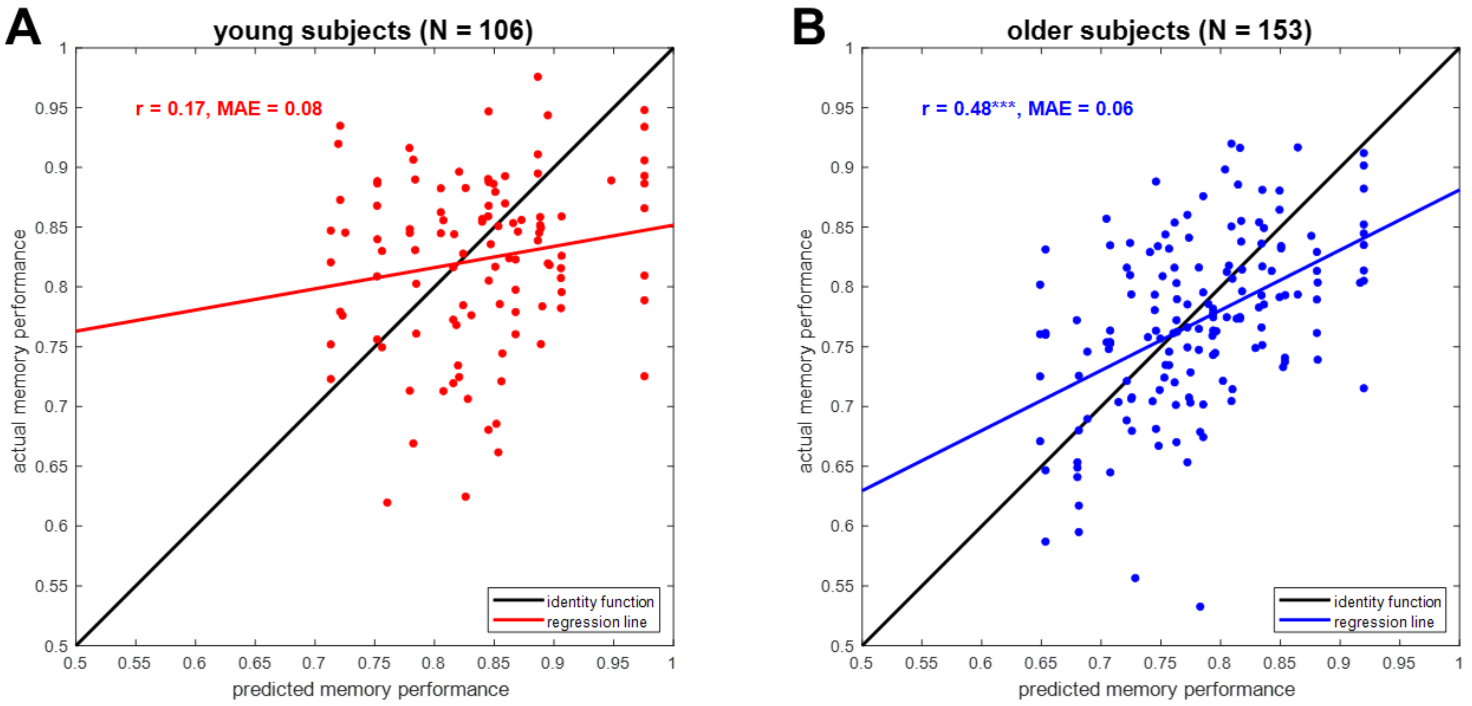
Appendix

Single-value fMRI scores outperform whole-brain fMRI contrasts in predicting independent memory performance.



Soch*, Richter* et al., in review, Fig. 4.

The predictive utility of fMRI scores for memory performance is still moderate.



Soch*, Richter* et al., in review, Fig. 6.