

INTRODUCTION

- Age-related changes in cognition have been linked to brain tissue changes including alterations of both structural and functional connectivity (FC)¹.
- The brain's upkeep of a steady supply of nutrients drives neurovascular coupling mechanisms via changes in blood flow (CBF), volume and metabolism culminating in the observed BOLD contrast changes².
- While age-related changes in FC using the BOLD contrast can be interesting, the relation between age-related changes in cerebral perfusion and FC can potentially unravel mechanisms more closely associated with neuronal processing³.
- Moreover, age-related changes in perfusion might introduce FC analyses biases and/or affect reliability

OBJECTIVE

The present work aims to explore the relationship between cortical perfusion and functional connectivity across the lifespan.

METHODS

- Human Connectome Project Aging (HCPA) data from 120 healthy subjects (mean age 59±14.1 yrs, 58 females) were used, including their:
 - T₁w MPRAGE,
 - pseudo-continuous ASL (pCASL + fieldmap) and
 - resting-state fMRI (rs-fMRI) data
 as specified in Harms et al. (2018)⁵.
- Perfusion data processing, perfusion quantification, arterial arrival time (AAT) estimation and coregistration to the subject's T₁w image were carried out using FSL's *oxford_asl* script.
- Functional images were processed using HCP's preprocessing framework to allow cortical surface-based analysis across subjects on ICA-FIX denoised, and multi-modal surface-matched (MSM) BOLD timeseries data⁶.
- The quantitative perfusion (ml/100g/min), AAT (s) and cortical thickness (mm) maps were then projected onto the mid-grey matter surface using the MSMALL-derived transformations.
- Subject-specific FC matrices were extracted from each run's timeseries and used to calculate an inter-run FC difference matrix.
- These were then averaged across all subjects, transformed into a single distance matrix and decomposed using nonlinear dimensionality reduction into a set of 1-D components, reflecting distinct aspects of inter-run variability⁷.

DISCUSSION

- The pCASL data show that on average the perfusion values fall within the expected range (~50-60 ml/100g/min, Fig 1A)⁸ but decreases with age (Fig. 1B)⁹. In contrast, AAT correlates positively with age¹⁰. The cortical thinning with age (Fig. 1B) will lead to different partial volume fractions and contribute to observed reduction in cortical perfusion values.
- We observe network-specific differences over age, with prominent reduction observed in visual and dorsal attention network ROIs.
- Interestingly, cortical nodes with distinct inter-run FC variability profiles significantly differ in terms of perfusion (Fig. 1D). This effect, however, weakens with progressing age.
- Future analyses aims to (i) expand towards the entire HCP-A dataset and (ii) improve the estimation of perfusion by using denoising approaches, corrections for multi-band acquisition, partial volume, AAT, T₁ and sex differences.

RESULTS

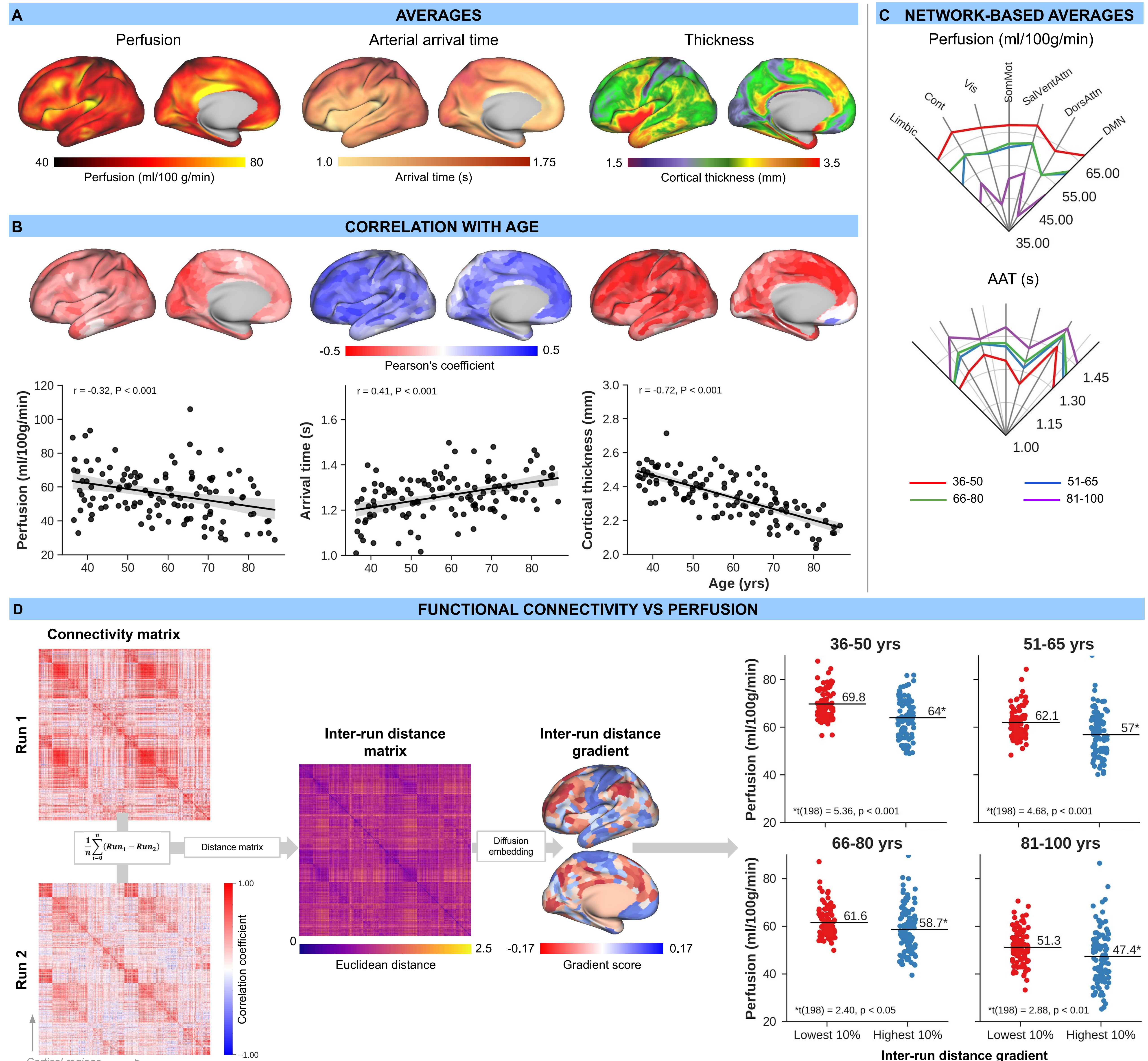


Figure 1 - (A, left-to-right) Cortical perfusion (in ml/100g/min), AAT (in s) and thickness (in mm) maps averaged across all datasets, (B) maps of Pearson's correlation coefficient between perfusion, AAT and thickness with age of participants mapped onto the inflated mid-grey matter surface. Only the left hemisphere surfaces are shown to illustrate the cortical spatial patterns but data from both hemispheres are used for the scatter plot. Shaded port around the trend line indicates 95% confidence interval. (C) Functional brain network-based averages for summarizing cortical perfusion (in ml/100g/min, top) and AAT (in s, bottom) across age groups. (D, left-to-right) Connectivity matrices extracted using the Schaeffer atlas from the BOLD timeseries for each run (top and bottom), inter-run (euclidean) distance matrix (i.e., high values indicate node pairs that differ substantially in their inter-run differences), largest one-dimensional component of the distance matrix mapped onto the cortical surface and most right, average perfusion values taken from the 10% lowest and highest regions based on this cortical gradient separated by age group.

ACKNOWLEDGEMENTS



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