Title: Age and education bear independent effects on functional brain networks

Alistair Perry¹²³, Wei Wen¹³, Nicole Kochan¹³, John Crawford¹³, Perminder Sachdev¹³, Michael Breakspear²

¹Centre for Healthy Brain Ageing, University of New South Wales, Sydney, Australia, ²QIMR Berghofer Medical Research Institute, Brisbane, Australia, ³University of New South Wales, Sydney, Australia

Background: Normal ageing is characterised by deleterious changes in cognitive processes which are associated with alterations in functional brain networks. However, the nature of the relationship between brain networks, age and cognition is poorly understood, and is further exacerbated by the potential mitigating factors of cognitive reserve. Investigations of such brain-behaviour processes have also largely been univariate, hence neglecting the complex inter-relationships between individual’s non-imaging demographic and behavioural features.

Methods: We leverage multivariate analysis to elucidate the combined influence of demographic and cognitive factors on functional brain networks of 101 cognitively-healthy elders (76-94 years), acquired from rs-fMRI data (3T). Canonical Correlation Analysis (CCA) identified three orthogonalized combinations of non-imaging measures and functional brain connectivity that capture independencies between brain-behaviour relations.

Results: The first mode ($F_{64,496} = 1.77, pF = 0.00043$) identifies a diffuse functional subnetwork whose expression opposes age against core cognitive processes, such as attention and processing speed. This bilateral functional subnetwork links lower-order sensorimotor and visual regions through key areas such as the parietal operculum and posterior insula. The second mode accounts ($F_{49,441} = 1.55, pF = 0.01$) for the strong independent association between educational attainment years and functional networks, whilst the third mode ($F_{36,384} = 1.48, pF = 0.04$) only captures weak associations between age, cognition and functional connectivity.

Conclusions: The opposing effect of age and attention and processing speed within the first mode suggests the integrative role of the parietal operculum and posterior insula is crucial to age-related changes in sensorimotor functioning. Interestingly, the influence of increased education on cognitive reserve is shown here to rather have a weak or null protective effect on this intrinsic age-related network. Increased educational attainment, on the other hand, possibly confers greater resilience to age-related cognitive decline by acting upon non-specific functional links between key hubs of default-mode and cognitive-control networks to all other functional subsystems.