

Relationship between IQ at different ages and functional brain connectivity in healthy ageing

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INTRODUCTION

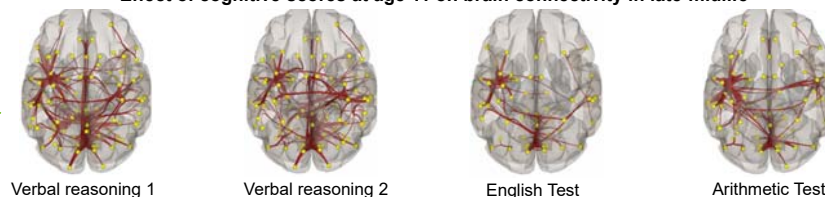
- Cognitive abilities are supported by specific functional brain connectivity.
- Fluid intelligence increases during childhood, reaching a maximum in midlife, followed by slow decline, which typically accelerates from late-midlife into old age.^[1]
- It has been shown that ageing can disrupt certain higher cognitive systems such as the default mode network, the salience network and the central executive network.^[2]
- Functional connectivity changes were most prominent for posterior parts of the brain and correlated across time with decreasing cognitive performance.^[3]
- We sought to investigate whether childhood (11y) and late-midlife (60-65y) cognitive ability was associated with functional brain connectivity in late-midlife.
- Based on previous evidence, we hypothesised that fronto-parietal and cingulo-opercular networks might be involved.^[4,5]
- Is resting state functional connectivity a biomarker of cognitive reserve and predicts age-related cognitive decline?

MATERIALS AND METHODS

- Participants (249) are a subset of the Aberdeen Children of the Nineteen Fifties cohort.
- The childhood cognitive scores (local school examination age 11) and a battery of cognitive tests age 60-65 were used.
- MRI included a volumetric scan (TR/TE=8.3/3.8ms; Matrix=240x240; n slices=160; thickness=1mm) and resting state fMRI (TR=1560ms, TE=26ms, 32 transverse slices, matrix=64x64, pixel size=3.39x3.39mm², slice thickness=4.5mm, volumes=195).
- Data were analysed using functional connectivity toolbox CONN v17. Functional connectivity ROI-to-ROI analyses were used to assess the networks associated with an IQ-like score at age 11 and at the current age (60-65). The target ROIs are selected from FSL Harvard Oxford and AAL (cerebellar areas only) atlases.
- The results were thresholded at FDR-corrected p<.05 for a one-sided (positive) inference.

RESULTS

Effect of cognitive scores at age 11 on brain connectivity in late-midlife

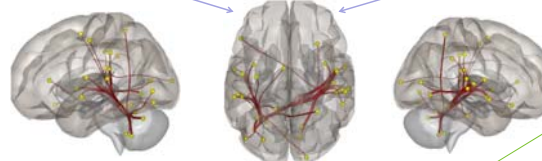


Verbal reasoning tests at age 11 are correlated with the strength of many connections seen in a late-midlife scan. These are spread over the whole brain.

The correlations between verbal fluency and the strength of connections in late-midlife involve less connections. The network is better represented in the left hemisphere.

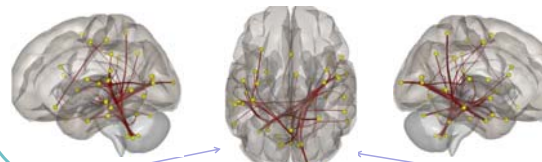
Mill Hill vocabulary is impressive through the strength of connections and interhemispheric links.

Effect of IQ-like score (extracted from the above tests) at age 11 on connectivity in late-midlife



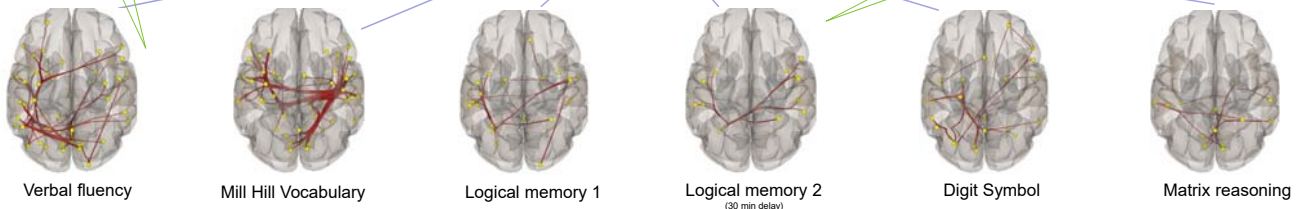
The IQ-like score was extracted using principal component analysis. The effects of these IQs at age 11 and at age 60-65 on functional connectivity acquired in late-midlife describe the networks shown in figures. The patterns of cingulo-opercular, cerebellar and fronto-parietal connections are similar for both ages.

Effect of IQ-like score (extracted from the below tests) at age 60-65 on connectivity at the same age (late-midlife)



The second logical memory test administered 30 min later than the first one shows clear by how a few connections have been lost.

Effect of cognitive scores at age 60-65 on connectivity at the same age (late-midlife)



CONCLUSION

- Assessing the effect of each cognitive test in childhood and later on in late-midlife on the functional brain connectivity from a late-midlife scan, we found that there are differences between ages. The strength of and many of the connections are lost with age. This might be interpreted through an obtained "efficiency" for a specific task in term of the connections and might be the effect of life experience (practice). The loss of connections can be attributed to ageing process too.
- Extracting the main features of these cognitive tests from childhood and late-midlife in an IQ-like score we found that their effects on connectivity are similar, suggesting sustained networks linked to IQ throughout life.

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