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?

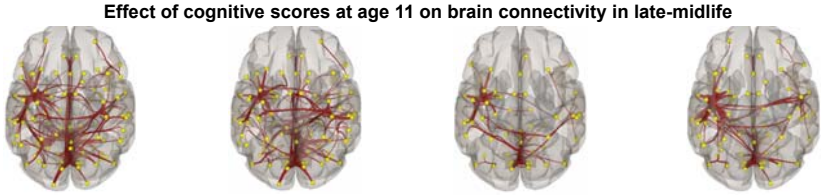
MATERIALS AND METHODS

- 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=3.39x3.39mm^2, 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

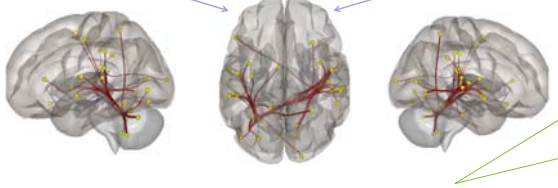
Effect of cognitive scores at age 11 on brain connectivity in late-midlife

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.



Verbal reasoning 1 | Verbal reasoning 2 | English Test | Arithmetic Test

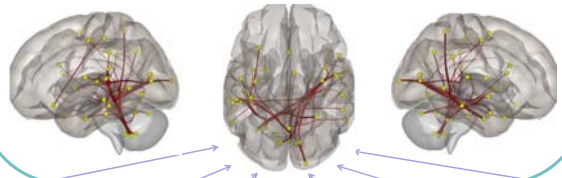
Effect of IQ-like score (extracted from the above tests) at age 11 on connectivity in late-midlife



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, cerebelar and fronto-parietal connections are similar for both ages.

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.

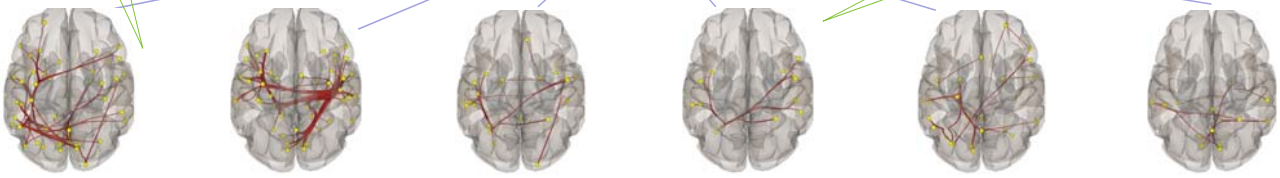
Effect of IQ-like score (extracted from the below tests) at age 60-65 on connectivity at the same age (late-midlife)



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

The second logical memory test administrated 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)



Verbal fluency | Mill Hill Vocabulary | Logical memory 1 | Logical memory 2 (30 min delay) | Digit Symbol | Matrix reasoning

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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