

EM 4

Crosstalk: The Impact of Cardiac Anatomy and Function on Brain Structure and Health				
Start date: 1 Mar 2016.			Completion date: 30 Jun 2019	
Overall objective(s): The proposal is to apply automated image analysis to heart and brain images acquired by the UK Biobank initiative. Specifically, evidence is sought for structural/functional correlates between heart and brain in a cross-section of the mature UK population with a focus on early indicators of adverse brain changes that might be coupled across the organs.				
Deliverables	Milestones	Milestone deadline	Work package dependencies	Person(s) responsible
Objective 1:				
D1.1 To establish best practice for working with imaging data via the DPUK secure portal	M1.1.1 Download and investigate brain MRI data and ensure access to cardiac MRI derived measures	M1.1.1 Complete		Williams, Matthews, Suzuki
Objective 2:				
D2.1 Adaptation of local computing infrastructure to process brain MRI data and link with systemic physiological measures	M2.1.1 Adaptation of infrastructure.	M2.1.1 Complete		Williams
D2.2- Detailed brain structural measures including hippocampal subfield volumes, cortical thickness undertaken followed by modelling	M2.2.1 ~2000 brains processed	M2.2.1 Complete		Williams
D2.3 Correlative analysis within the brain and heart of imaged subset	D2.3.1 Ongoing work	D2.3.1 Complete		
Objective 3:				
D3.1 Presentation of results at Human Brain Mapping Conference 17-21 June 2018	M3.1.1 Work accepted for poster presentation	M3.1.1 Complete		Worker, Dima, Williams
D3.2- Manuscript submission to Hypertension in March 2018	M3.2.1 Manuscript submission	M3.2.1 Complete		Worker, Dima, Williams
Objective 4:				
D4.1 Data available in UKBiobank	M4.1.1 Make data available in UKBiobank	M4.1.1 Submitted to UKBB		Worker, Dima, Williams
Updates on delivery against milestones since last report				
<ul style="list-style-type: none"> M3.2.1 Manuscript currently still under review 				
Awaiting final responses from journal				
Summary of plan to deliver on outstanding work (with dates)				
We have two manuscripts under review and are awaiting responses from reviewers. We will continue to follow this and chase the editor of the journal if necessary. We anticipate having both papers accepted for publication in the first quarter of 2020.				
Risks		Mitigation		
1) Paper 1 not accepted 2) Paper 2 not accepted		1) Revise and resubmit to another journal 2) Revise and resubmit to another journal		
Team members funded (full or part-time) by DPUK				

Amanda Worker - PhD student

Team members involved with the project but not funded by DPUK

Steve Williams, Bill Crum, Mike O'Sullivan, Joanna Wardlaw, Philip Bath, Matthew Robson, Steffen Petersen, Derek Hill

Outcomes

- Adaptation of local computing infrastructure for the processing of brain MRI data
- Meta-analysis and systematic review to inform decisions on UK Biobank analysis
- Presentation of meta-analysis at the Organisation of Human Brain Mapping 2018
- Image processing of ~13,000 brain scans
- Analysis of both structural and functional MRI data with cardiac MR data and systemic physiological measures. Results from these analyses show that neuronal activity within the medial orbitofrontal cortex is abnormally low in individuals with high left ventricular ejection fraction and that this is related to scores of fluid intelligence.
- Presentation of results from analysis of cardiac MRI and brain measures at the Organisation Human Brain Mapping 2019
- Submission of cardiac/brain results to a journal – this is ongoing (manuscript available on request).
- Analysis of functional connectivity in untreated, successfully treated and unsuccessfully treated hypertension. Results show that people with hypertension have reduced functional connectivity both within the anterior insula and from the anterior to other regions including the anterior cingulate gyrus. These differences remain after successfully lowering of blood pressure with anti-hypertensive medication suggesting the results are not entirely driven by current high blood pressure.
- Submission of functional connectivity in hypertension paper – this is ongoing (manuscript available on request).

Project narrative

The brain and the heart are two organs which have been studied more than any other, providing a profound, though still incomplete, understanding of development, ageing and pathology. Imaging studies have allowed investigation of the structure of the brain and heart but imaging these organs in isolation has not provided a comprehensive understanding of systemic vascular risk. The aim of the investigation was to apply automated image analysis to heart and brain images acquired by the UK Biobank Initiative. We have looked for early evidence of structural/functional correlates between the heart and brain in a cross-section of the mature UK adult population. We have focused on early indicators of adverse brain changes which are coupled across organs. This has provided us with evidence that abnormalities in both cardiac and vascular (blood pressure/hypertension) function are coupled with abnormalities in brain structure and function as well as cognitive decline. The results from these analyses provide additional motivation for further research into systemic age-related and pathological effects of cardiovascular function on the brain and vice versa.