Project Details	
Project Code	NMH27Ca Cercignani
Title	Mapping the Developing Brain: Linking Structure and Function through Imaging
Research Theme	Neuroscience & Mental Health
Project Type	Other
Summary	This PhD project explores how young children's brain develops during the first five years of life and how this shapes thinking, language, and self-control. Using data from 300 children, the study combines brain imaging methods (MRI, EEG, and fNIRS) with behavioural assessments. It aims to understand how brain structure and activity work together as skills emerge, with a strong focus on modelling brain microstructure using MRI, and linking it with neurophysiological measures of function. Ultimately, this work could help improve early interventions, supporting children's development before they start school and setting stronger foundations for lifelong learning and wellbeing.
Description	Background: Early childhood is a period of rapid and dynamic development during which foundational cognitive skills emerge and consolidate, shaping later academic achievement and socio-emotional functioning. By the time children enter formal schooling, individual differences in these outcomes are already relatively stable and often persist into adulthood. Three early-developing domains – processing efficiency, language, and executive functions – are particularly critical, yet their developmental trajectories and interactions remain poorly understood, particularly in terms of how early brain structure and function give rise to these cognitive abilities. The Wellcome-funded BLOCCS study (Bristol Longitudinal study Of Childhood Cognition from infancy to School) addresses this gap by following 300 children from the ALSPAC Generation 2 cohort (also known as 'Children of the Children of the 90s') longitudinally from infancy to school entry, with repeated behavioural, neuroimaging, and neurophysiological assessments. This unique, multimodal dataset offers an unprecedented opportunity to characterise how cognitive abilities co-develop with structural and functional brain changes, and how these interactions give rise to individual differences in later outcomes. Within the broader framework of BLOCCS, this PhD studentship will focus on combining structural MRI data with functional data, such as fNIRS and EEG data, to provide a novel avenue to understand brain-behaviour relationships across early development. In addition, it will offer the opportunity to develop novel approaches to characterise microstructural brain development in infants and toddlers, and to integrate this information with functional imaging data. The student will also explore approaches to link these measures to longitudinal behavioural trajectories. Addressing these challenges is essential for identifying early neural markers of risk and resilience and informing targeted interventions before school entry. Key research question: How does structural and functional brain development, captured through MRI, high-density fNIRS and EEG measures, associate with the development of processing speed, language, and executive functions during the first five years of life, and

	how can these multimodal markers be integrated to predict emerging cognitive and socio-emotional outcomes? Specific Objectives: Over the course of the studentship, the student will: 1. Characterise early brain microstructure They will apply and evaluate advanced diffusion MRI and microstructural modelling approaches in infants and toddlers; they will also identify developmental trajectories of key brain systems supporting language, executive functions, and processing efficiency. 2. Integrate multimodal neuroimaging data They will develop approaches to combine structural MRI with high-density fNIRS (including head model integration and diffuse optical tomography) and EEG measures of brain function in babies and toddlers. Using these tools, they will examine how structural connectivity and brain maturation relate to functional activation patterns in early childhood. 3. Link brain development to cognitive trajectories They will contribute to the overall objectives of the project, including modelling longitudinal associations between brain measures and behavioural assessments of core cognitive domains. Student ownership and opportunities: The student will be able to: • Lead the implementation and optimisation of novel microstructural MRI models in very young populations, an emerging and high-impact area. • Contribute to the development of innovative multimodal data integration pipelines, combining MRI, fNIRS, EEG, and behavioural data. • Shape specific research questions within the broader framework (e.g., focusing on a particular cognitive domain or neural system). • Generate independent publications, including at least one first-author paper on methodological innovation and one on cognitive neuroscience findings. The student will gain cutting-edge skills in neuroimaging, developmental cognitive neuroscience, and advanced data analysis, including integrating multiple types of brain and behavioural data. They will also benefit from working across the Bristol University Baby Lab and Cardiff University Brain Research Imaging Centre, two world-leading facilities in their respective fields. As such, the student will have access to leading expertise, state-of-the-art equipment, and a rich, collaborative research environment.
Can be completed part time?	Yes
Supervisory Team	
Lead Supervisor	
Name	Professor Mara Cercignani
Affiliation	Cardiff
College/Faculty	College of Biomedical & Life Sciences
Department/School	School of Psychology
Email Address	cercignanim@cardiff.ac.uk
Co-Supervisor 1	
Name	Professor Karla Holmboe
Affiliation	Bristol

College/Faculty	Health and Life Sciences
Department/School	School of Psychological Science
Co-Supervisor 2	
Name	Dr Marco Palombo
Affiliation	Cardiff
College/Faculty	College of Physical Sciences and Engineering
Department/School	Computer Science
Co-Supervisor 3	
Name	
Affiliation	
College/Faculty	
Department/School	