NSERC Discovery Award Summary for Dr. L.L. Emberson

Developmental cognitive neuroscience holds great promise for furthering our understanding of fundamental neural and psychological mechanisms are established in infancy. Yet while much work has demonstrated that infants show rapid changes in both their brain and behaviour as a result of short-term learning experiences, very little work has explored how these short-term changes relate to the development of functional, or task-based, connectivity in the infant brain, and to other long-term developmental changes. Importantly, key predictions of the neural-interactionist theoretical approach (a central tenet in developmental cognitive neuroscience) remain largely untested.

Towards the long-term research goal of understanding how short- and long-term changes in the infant brain and behaviour interrelate and give rise to one another, my research program will leverage recent advances in infant task-based functional connectivity to investigate the still untested neural-interactionist prediction that longer-term developmental changes can occur through the involvement of higher-level neural regions during short-term experiences. I will use a combination of functional Near-Infrared Spectroscopy (fNIRS), sensitive behavioural methods and computational analytic approaches to test these predictions in three interrelated research streams. Research Stream 1 will examine the role of functional neural networks in short-term learning-based changes in perception, integrating eye-tracking and fNIRS approaches. We hypothesize that the frontal lobe is crucially involved in short-term, learning changes in perception. Research Stream 2 will explore how short-term changes in perception, as measured in behaviour, give rise to longer-term changes in representations. Three theoretically-motivated training protocols are planned. Then, we will use fNIRS to see whether these short-term changes become independent of the frontal lobe. Research Stream 3 will investigate how short-term neural engagement of the infant brain (for example, in long-range neural networks) supports longer-term, developmental emergence of key neural networks. Research Stream 3 will examine 3 data sets from high- and low-income families – two previously collected samples from subSaharan Africa and the United Kingdom, and a third proposed data set to be gathered from 150+ Canadian infants longitudinally, examining how performance during active sequence learning and prediction tasks relates to neural network activation across the first two years of life. Together, this research will provide insight into how infants' task engagement during short-term learning experiences gives rise to long-term, developmental changes. We will test key theoretical prediction; this work is expected to give insights into fundamental mechanisms supporting how the brain is built through experience