CHANGES IN NEUROVASCULAR COUPLING AS AN INDICATOR OF CEREBRAL HEALTH

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Neurovascular coupling (NVC) is defined as the close spatial and temporal relationship between neuronal activity and hemodynamic changes. The coupling is typically described by a hemodynamic response function (HRF), which links a neural input to the hemodynamic response to a stimulus. Neurovascular coupling is known to be altered in some disease states, especially when vascular integrity and cerebral autoregulation is impaired. Using a combination of neural sensing methods, such as electroencephalography (EEG), combined with vascular sensing, such as near-infrared spectroscopy (NIRS) or diffuse correlation spectroscopy (DCS), the HRF can be calculated directly. Using a multi-modal approach for HRF estimation, we have recently evaluated whether the HRF can be a useful indicator of cerebral health in the context of loss of cerebral autoregulation. Specifically, we have shown that the shape of the HRF changes with cerebral perfusion pressure (CPP) at levels that indicate loss of autoregulation, as shown in Figure 1, on top of the Lassen's autoregulation curve. These results indicate that NVC can act as a non-invasive, bedside-compatible biomarker for cerebral autoregulatory assessment.

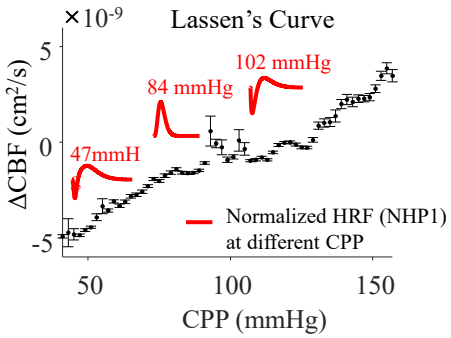

Figure 1. Changes in HRF (red) as a function of blood flow regulation.

In addition to pathological conditions, we are asking whether changes in arousal can impact neuronal and vascular signals. The term arousal is broad, encompassing cognitive concepts such as wakefulness, engagement with our environment, and alertness. Arousal changes are also linked with systemic physiology as well as behavior. Neurologic disorders, such as schizophrenia and Alzheimer's, are accompanied by cognitive deficits in arousal as well as systemic changes such as heart rate and pupil diameter. To understand why these clinical arousal changes occur and to use non-invasive systemic metrics diagnostically, we need to integrate our understanding of arousal across brain activity, systemic physiology, and behavior in neurotypical cognition. Here we will present our findings from non-human primate studies, where we show that the hemodynamic response to a stimulus, as measured with NIRS, fluctuates over the course of a session and is correlated with arousal drifts. The results presented here are a step towards identifying changes due to arousal modulation that link to non-invasive, systemic physiology and result in behavioral changes.