Title: Modeling Changes in Effective Connectivity Across Arousal States: An Intracranial Electrophysiology Study

Presenting Author: Christopher M. Endemann

Authors: Christopher M. Endemann, Department of Anesthesia, University of Wisconsin School of Medicine and Public Health, Declan Campbell, Department of Anesthesia, University of Wisconsin School of Medicine and Public Health, Bryan M. Krause, Department of Anesthesia, University of Wisconsin School of Medicine and Public Health, Kirill V. Nourski, Dept Neurosurgery, University of Iowa, Barry V. Veen, Department of Electrical and Computer Engineering, University of Wisconsin-Madison, Matthew I. Banks, Department of Anesthesia, University of Wisconsin School of Medicine and Public Health

Abstract: 1.5

Accumulating evidence suggests that cortical feedback (FB) connectivity is disrupted specifically compared to feedforward (FF) upon loss of consciousness under anesthesia. This result, if confirmed, would have profound implications not only for mechanisms of anesthesia, but also more generally for the neural basis of consciousness. However, there remain several unresolved issues in this regard. First, most of this evidence is derived from non-invasive EEG or MEG recordings in human subjects. Second, whether this result generalizes to loss of consciousness under other conditions, such as natural sleep, is uncertain. Third, estimating effective connectivity from electrophysiological recordings sampling large numbers of nodes in the cortical network is challenging due to limitations on the number of parameters it is possible to estimate from limited data. Here, we used sparse multivariate autoregressive models to estimate effective connectivity networks from intracranial electrophysiological data recorded in five subjects during distinct arousal states that occur during natural sleep [wake (WS), REM, N1, N2] and propofol anesthesia [pre-drug wake (WA), sedated/responsive (S) and unresponsive (U)]. To make this modeling procedure feasible with our high-dimensional datasets (100-200 channels per subject), we apply principle component analysis (PCA) as a preprocessing step to reduce total channel count within each ROI, and group lasso to eliminate unnecessary parameters (connections) during model fitting. We then use block connectivity measures to assess how individual ROIs communicate with one another within the auditory cortical hierarchy (core, belt, auditory-related and prefrontal cortex) and investigate changes with arousal state. We found that alpha-band FB connectivity was consistently larger than FF. Surprisingly, no consistent changes were observed across arousal state under anesthesia, while FB connectivity decreased in all five subjects from WS to N2. These results suggest that disrupted FB connectivity under anesthesia may not be as prominent or consistent a feature as previously thought.