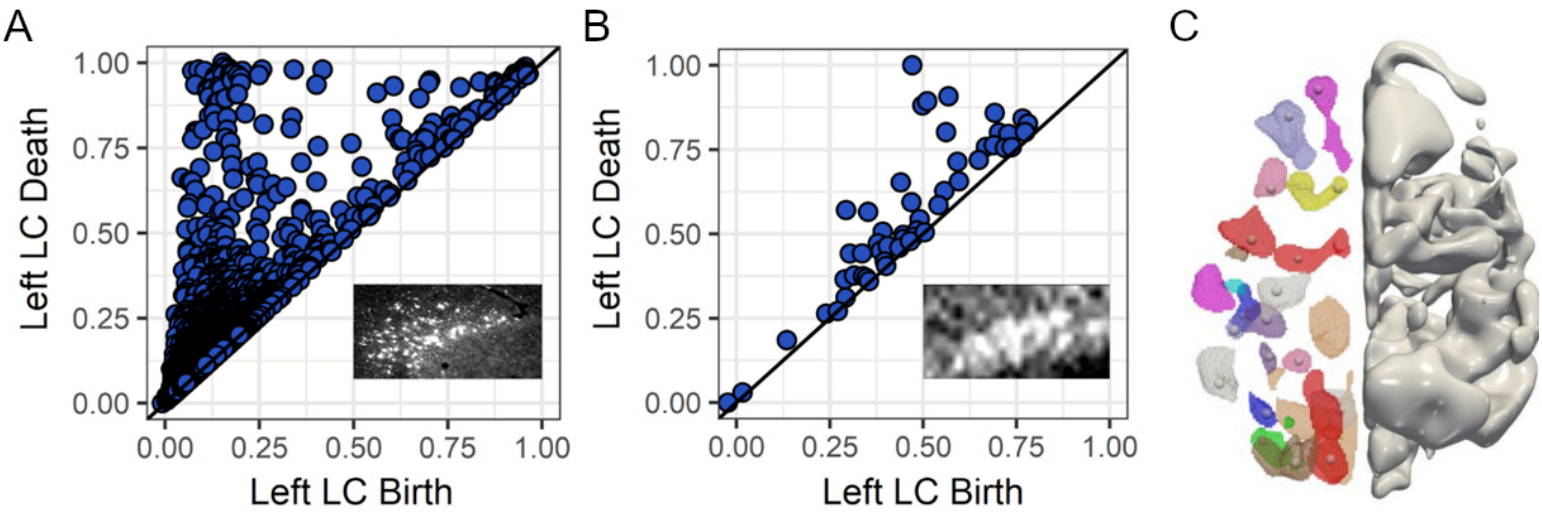
CBI Featured Image – Fall 2023

Courtesy of Mark Eckert, Ph.D., Department of Otolaryngology



Persistent homology is a topological data analysis approach used for quantifying the shape of data and reducing dimensionality. The Eckert laboratory, in collaboration with Federico Iuricich at Clemson University, has used this approach to characterize brain structure in studies of cognitive processing speed (1) and reading disability (2). Figure 1A,B shows how persistent homology can quantify locus coeruleus (LC) structure by its low contrast boundary and its peak voxel value in histology and corresponding data from the same tissue imaged in the CBI 7T system. These boundaries are presented in a persistence diagram where the x- and y-axes represent the low contrast "birth" (minimum) and high contrast "death" (maximum) for each neuromelanin-containing neuron (Figure 1A) and nucleus contrast (Figure 1B). This approach was used to show a significant association between LC structure and cognitive processing speed in human participants (1). In a separate study, persistent homology was used to define brain structure asymmetries (Figure 1C rendering of asymmetry boundaries), which were associated with reading skill in children and adults (2).

1. Eckert, M. A., Iuricich, F., Harris, K. C., Hamlett, E. D., Vazey, E. M., & Aston-Jones, G. (2023). Locus coeruleus and dorsal cingulate morphology contributions to slowed processing speed. Neuropsychologia, 179, 108449.

2. Eckert, M. A., Vaden Jr, K. I., Iuricich, F., & Dyslexia Data Consortium. (2022). Cortical asymmetries at different spatial hierarchies relate to phonological processing ability. PLoS Biology, 20(4), e3001591.