Morpho-electric properties and computational simulation of human dentate gyrus granule cells from the epileptogenic hippocampus

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Summary

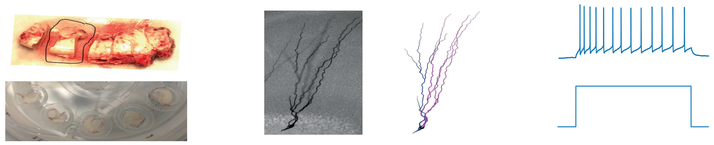
Epilepsy is the fourth most common neurological disorder, and is responsible for a greater total global burden of disease than any neurological condition except stroke or migraine. Hippocampal sclerosis is often correlated with seizures. The degree of sclerosis is characterised by **Wyler Grade (WG)**, where **WG1** is less severe and **WG4** is more severe.

Electrophysiology: we found statistically significant differences in firing properties of human granule cells from dentate gyrus with different degree of hippocampal sclerosis (**WG1** vs. **WG4**).

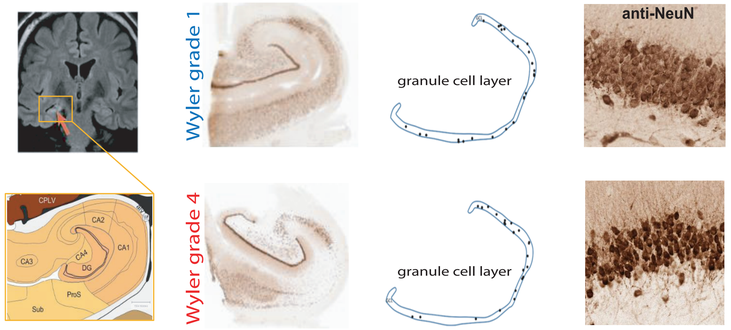
Morphology: the detailed morphological analysis did not reveal any statistically significant differences in granule cell morphological features for **WG1** vs. **WG4**. We found that **WG4** granule cells have approximately double the spine density as compared to **WG1** cells.

Modeling: we developed the novel computational model of granule cells with active dendrites capable of reproducing the electrophysiological behavior of hippocampal granule cells. Using the granule cell model we found that addition of **WG4** cells to **dentate gyrus** circuit leads to the development of synchronous activity.

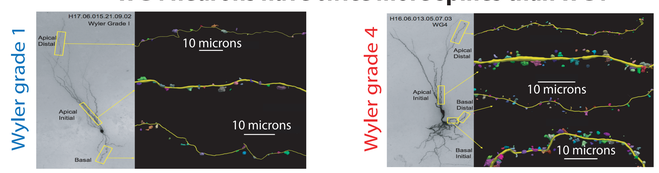
Tissue processing | **Morphology** | **Electrophysiology**

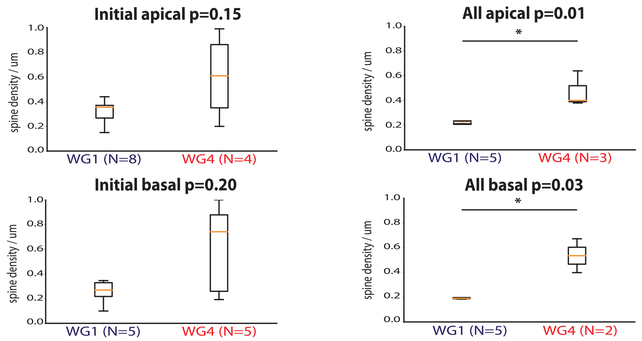


Granule cells are equally sampled from human dentate gyrus

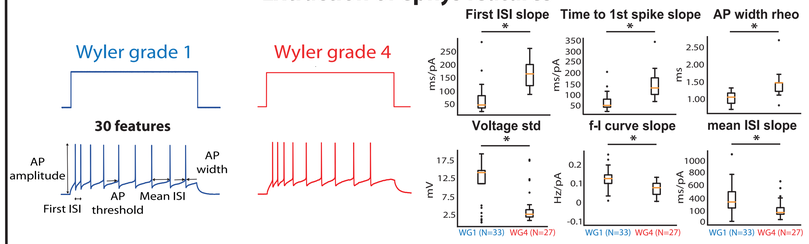


WG4 neurons have twice more spines than WG1

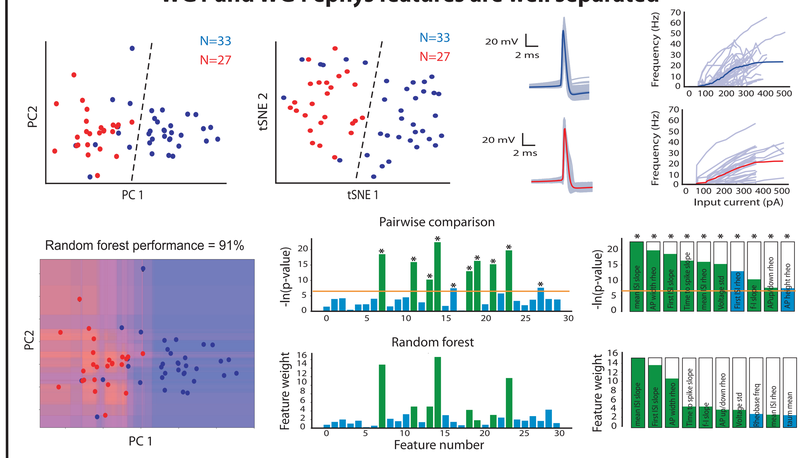




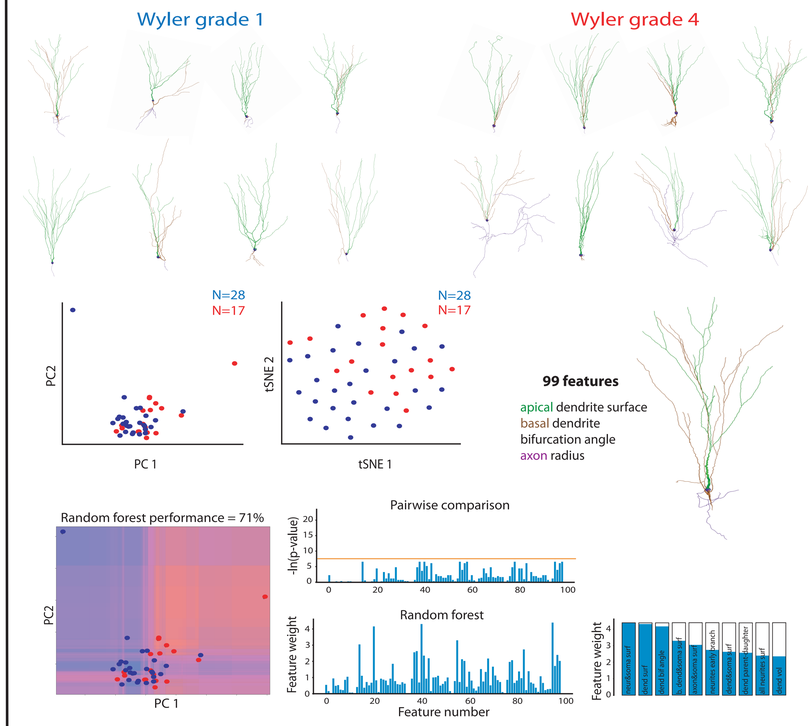
Extraction of ephys features



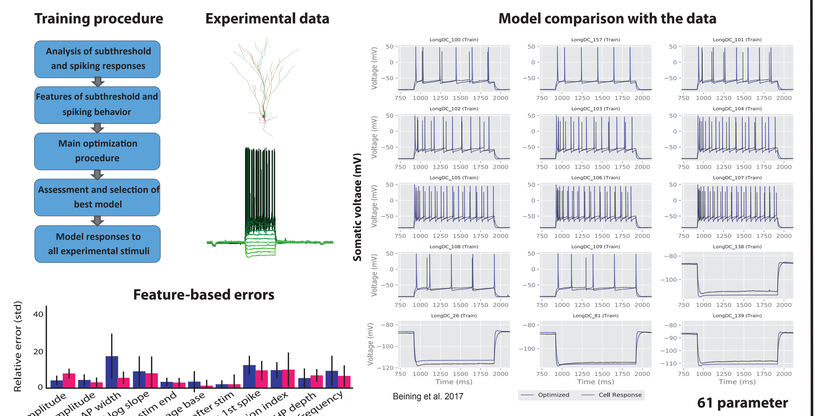
WG1 and WG4 ephys features are well separated



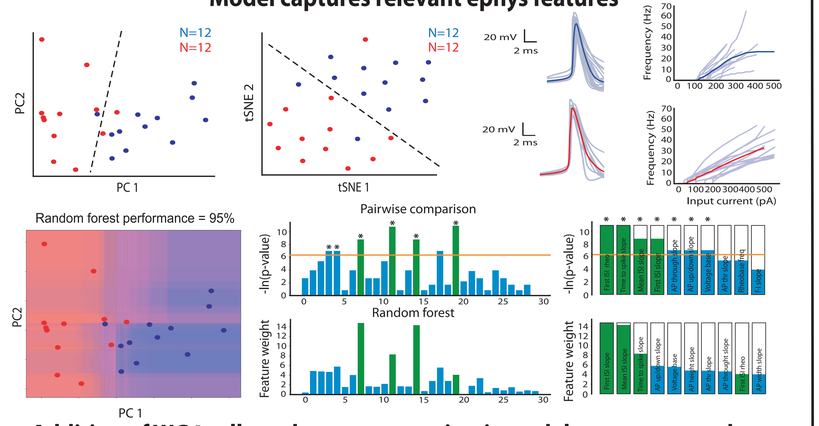
Morphological features are similar between WG1 and WG4 cells



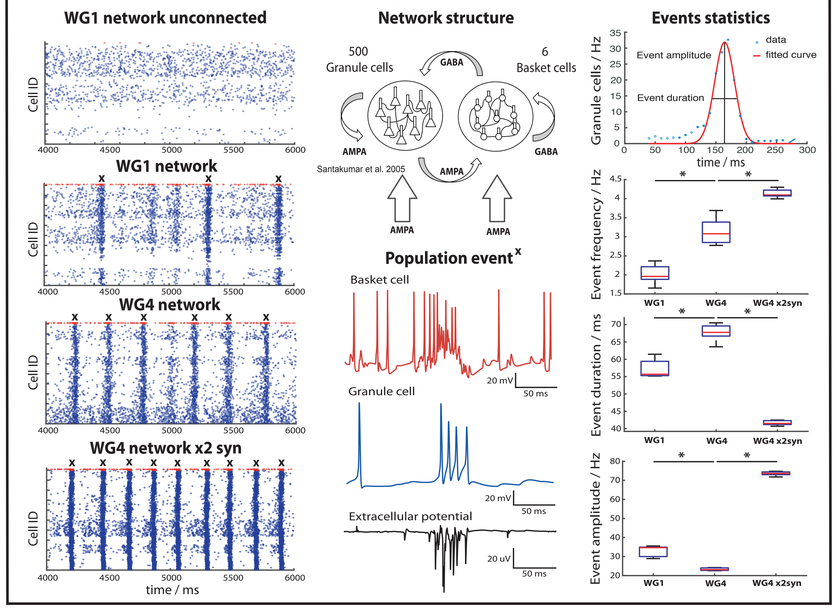
Computational model of granule cells



Model captures relevant ephys features



Addition of WG4 cells to dentate gyrus circuit model promotes synchrony



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