USING RQA ANALYSIS TO IDENTIFY AND PROFILE ABSENCE SEIZURES IN STARGAZER MICE

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Absence epilepsy [1] interrupts normal cortical processing, producing reversible episodes of altered consciousness. These events can provide unique functional insight into the coupling of human perception and volition. The stargazer model, one of over 20 monogenic mouse mutants with this phenotype [1], displays frequent, recurrent spike-wave seizures with behavioural arrest. We aim to detect neural state changes from the patterns of firing recorded by 2-photon imaging in L2/3 of the stargazer mouse visual cortex. The L2/3 was imaged using the GCamp6 construct in alert awake animals, with simultaneously recorded EEG. For each ROI, we calculate the aggregate number of spikes per consecutive non-overlapping 15-frame windows. Finally, a population spike train is estimated based on neurons that had the maximal discriminability between ictal and non-ictal periods (as marked by the epileptologist reviewing and analyzing the corresponding EEG measurements).

We report our preliminary results on the first mouse using RQA, a powerful nonlinear analysis of time series, which quantifies recurrence structures and detects the critical transitions in the system's dynamics (*e.g.*, deterministic, stochastic) [2]. It can accurately detect the onset and offset of ictal events with high sensitivity above chance. Interestingly, RQA detects substructures within the ictal and interictal periods. We are in the process of characterizing them based on their duration, mean firing rate, number of highly active and quiet neurons. For example, we found that the RQA events that match the ictal onsets are of shorter duration and higher mean firing rate compared to the typical ictal periods. Recently we showed that SVM can accurately classify 1-sec windows as ictal or interictal [3]. Here we identify the seizure onsets and offsets. Our long-term objective is to identify the activity pattern of groups of neurons that can be employed to predict the seizures.

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References

1. Maheshwari, Noebels, 2014, *Prog Brain Res.*, 213:223–252, 10.1016/B978-0-444-63326-2.00012-0
2. Marwan, *et al.*, 2007, *Physics Reports*, 438(5–6):237–329, 10.1016/j.physrep.2006.11.001
3. Zacharakis, Kampourakis, *et al.*, 2019, *IEEE BIBE*, 783–790, 10.1109/BIBE.2019.00146