Spontaneous Reverberation in Developing Neuronal Culture Networks

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Spontaneous activities in neuronal cultures are recorded by a MEA system and calcium image. A synchronized burst is characterized by the histogram (Figure 1) of spiking time averaged over the 60 electrodes.

These histograms are studied as a function of DIV. As the cultures mature, the time interval between burst and burst duration become shorter. The structure of the histogram shows that the neurons are firing more or less periodically with the time interval of 100ms; similar to reverberation at early DIV. Figure 1 shows changes of the structure of the histograms as a function of DIV. It can be seen that the periodic structures of the histogram disappear as the culture mature.

Pharmacology is used to understand the possible causes for the changes in histogram; such as network connectivity. We study how these histograms change with the addition of BMI (suppression of inhibitory connections) or removal of magnesium (enhancement of excitatory connections) in the culture medium and compare the results of histogram with different DIV. The results show that the reverberation can be eliminated by the addition of glutamate and induced by the removal of magnesium or addition of bicuculline in the culture media.

The experiment shows that network activities change during development. Reverberation can only be observed when the DIV of the cultures are less than 13±3. Results of pharmacology show that the observed changes in histogram originate from the changes of network connectivity. Different patterns of histograms observed during development can also be induced by the use of pharmacology. All these results suggest that the observed reverberation is the results of network dynamics.
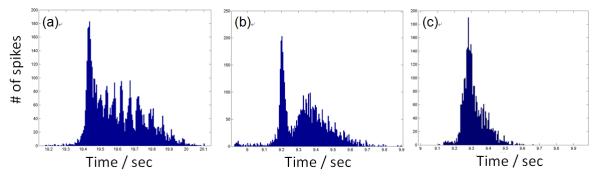

Figure 1. Histograms of spontaneous activity with 5ms time bin at a) 10DIV, b) 17DIV and c) 20DIV.