# Modeling the Dynamics of Neurons of the Mammalian Inferior Colliculus


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We are developing computational models of IC neurons and networks based on experimental data to gain an understanding of what accounts for the firing patterns of these cells and what information they provide to higher levels.

Our models are exploring the types of IC neurons described by Sivaramakrishnan and Oliver (J Neuroscience 21:2861-2877, 2001), The cell types modeled are shown in Figures 1-4 from Sivaramakrishnan and Oliver (2001).

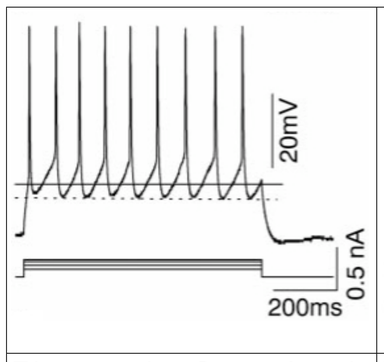


Figure 1. Sustained-regular firing pattern *in vivo.* (From Figure 2)

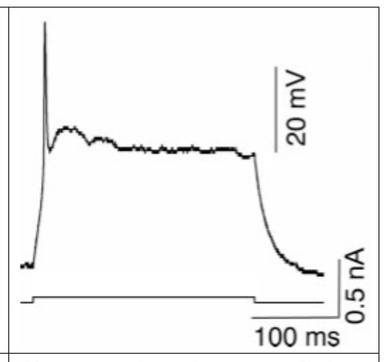


Figure 2. Onset firing pattern *in vivo.* (From Figure 8)

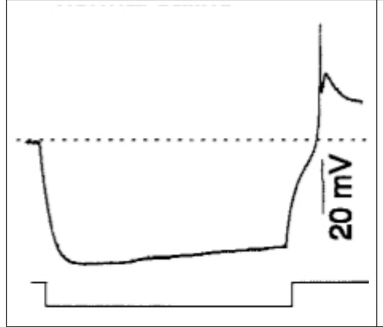


Figure 3. An example of the rebound firing pattern *in vivo.* (From Figure 10)

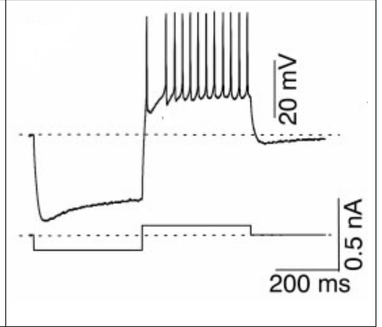


Figure 4. Build-up and pause firing pattern *in vivo.* (From Figure 11)

We are using the GENESIS neural system simulation platform (Wilson M, et al, 1991). Most GENESIS simulations are based on a small collection of generalized channel models, but our channel models incorporate information from more recent publications to allow validation against recent experimental results. All models have specialised Na and K channels, the rebound cells also contain Ca T-channels and the pause-build cells contain Kv 4.2 channels.

Figure 5 shows model results for the sustained-regular cell. The Na and K channels need more depolarised activation thresholds and slower time constants than normal to produce dynamics similar to those *in vivo*. Figure 6 shows very preliminary results for an onset cell. This cell has a high-threshold K channel that is not yet incorporated in the model, but it already shows realistic dynamics. Figure 7 shows similar results for a rebound cell. Figure 8 shows a pause-build cell. In the pause-build cell, the fast time constant of the Kv4.2 channel coupled with the slow time constant of the sodium channels eliminates the anode spike seen *in vivo*, suggesting that the A-type K channels in that cell have a longer time constant.


## Acknowledgements

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## References


Sivaramakrishnan, S. and D.L. Oliver, 2001. Distinct K Currents Result in Physiologically Distinct Cell Types in the Inferior Colliculus of Rat. *Journal of Neuroscience,* 21(8): p. 2861-2877.

Wilson, M., et al. 1991, *GENESIS, the Caltech Neural Network Simulator.* Available by ftp from: ftp://genesis.caltech.edu/.


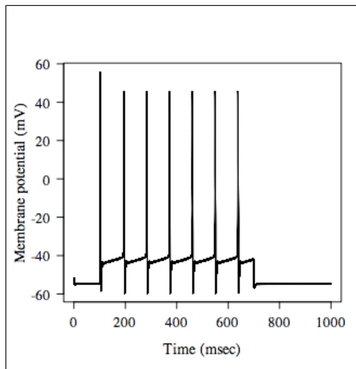


Figure 5. Sustained-regular firing pattern. Current injection is between 100 and 700 msec.

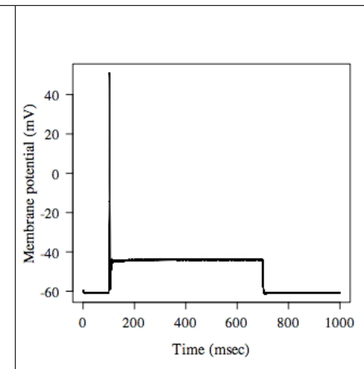


Figure 6. Onset firing pattern. Preliminary results based on the sustained-regular cell with a reduced Na channel density.

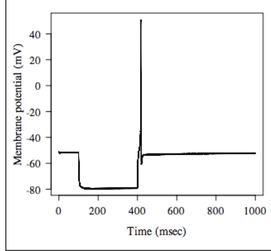


Figure 7. Rebound firing pattern, preliminary results. The Ca spike is generated by a standard T-channel. A T-channel with a longer time constant will probably be needed to produce the slower and more pronounced Ca spike seen *in vivo*.

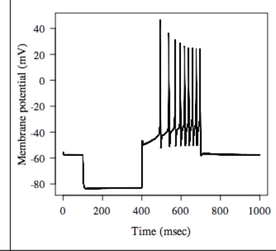


Figure 8. Pause-build firing pattern, preliminary results. The anode spike seen *in vivo* at the end of current injection is probably missing because the fast time constant of the standard Kv4.2 channel blocks the response of the slower Na channels in the model.