Journal of Computational Neuroscience 2015 vol.39 N2, pages 119-129

Bayesian analysis of the kinetics of quantal transmitter secretion at the neuromuscular junction

Saveliev A., Khuzakhmetova V., Samigullin D., Skorinkin A., Kovyazina I., Nikolsky E., Bukharaeva E.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2015, Springer Science+Business Media New York. The timing of transmitter release from nerve endings is considered nowadays as one of the factors determining the plasticity and efficacy of synaptic transmission. In the neuromuscular junction, the moments of release of individual acetylcholine quanta are related to the synaptic delays of uniquantal endplate currents recorded under conditions of lowered extracellular calcium. Using Bayesian modelling, we performed a statistical analysis of synaptic delays in mouse neuromuscular junction with different patterns of rhythmic nerve stimulation and when the entry of calcium ions into the nerve terminal was modified. We have obtained a statistical model of the release timing which is represented as the summation of two independent statistical distributions. The first of these is the exponentially modified Gaussian distribution. The mixture of normal and exponential components in this distribution can be interpreted as a two-stage mechanism of early and late periods of phasic synchronous secretion. The parameters of this distribution depend on both the stimulation frequency of the motor nerve and the calcium ions' entry conditions. The second distribution was modelled as quasi-uniform, with parameters independent of nerve stimulation frequency and calcium entry. Two different probability density functions for the distribution of synaptic delays suggest at least two independent processes controlling the time course of secretion, one of them potentially involving two stages. The relative contribution of these processes to the total number of mediator quanta released depends differently on the motor nerve stimulation pattern and on calcium ion entry into nerve endings.

http://dx.doi.org/10.1007/s10827-015-0567-3

Keywords

Kinetics of quantal secretion, Neuromuscular junction, Quantal release of neurotransmitter, Statistical model, Bayesian method