Abstract View

INDEPENDENT SOURCES OF QUANTAL VARIABILITY AT A CENTRAL GLUTAMATERGIC SYNAPSE

K.M. Franks[1,2*]; C.F. Stevens[1,2]; T.J. Sejnowski[1,2]

1. Salk Institute, La Jolla, CA, USA
2. Howard Hughes Medical Institute, La Jolla, CA, USA

Repeated stimulation at a single glutamatergic synapse typically produces highly variable postsynaptic responses. Bekkers et al (1) proposed that jitter in vesicle diameter, and thus, quantal content (q) could account for this variability. We used MCell, a Monte Carlo simulation program, to determine the relative contributions of different sources of this variance. The model consisted of a synapse containing 80 AMPA receptors (AMPARs) and randomly assigned release locations across the active zone (AZ) embedded within a spatially complex 3-D neuropil. Quantal release resulted in an average of 14 AMPA receptors (AMPARs) opening at peak (CV 0.46). Three sources of variability were then examined in isolation: Channel noise, variability in q, and eccentricity of the release location within the active zone (Δx). Release with fixed q and Δx=0 isolated channel noise and produced a normal distribution of peaks (μ, 22; CV, 0.17). Jitter in vesicle size (diam: 35nm±3.8nm) did not affect the mean but increased variability (CV 0.34) and skewed the distribution of peaks as predicted (1). Quantal size systematically decreased with increasing Δx, a 2-fold difference between release in the center and edge of the AZ. Release from 50 locations, with fixed q, gave a CV of 0.34. The variances from the three different sources sum to the total,consistent with their independent contribution to experimentally observed variance. Increased potency of clustered receptors and a non-linear transformation relation between receptor number and quantal response follow from release-location dependence.

(1) Bekkers JM, GB Richardson & CF Stevens (1990). PNAS 87: 5359-5362.
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