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Optimisation of analysis of non-stationary fluctuations of exocytotic capacitance changes in mouse inner hair cells

Inner hair cells exhibit a particular presynaptic structure, the ribbon, characteristic for some cell types producing graded potentials. It has been postulated that the ribbons act as an attractor for the vesicles, enabling the synapses to sustain very high rates of vesicular release. Recently, evidence for multivesicular release has been obtained in immature mouse inner hair cells. Compound fusion has been proposed as an underlying release mechanism.

This work contributes to the attempt to estimate the apparent quantal vesicle size via patch-clamp lock-in measurements of stimulus-evoked capacitance step fluctuations of the hair cell. We develop enhancements of non-stationary fluctuation analysis of capacitance steps. For example, we use a demixing procedure to diminish crosstalk in the lock-in channels and employ balanced bootstrapping as a randomisation procedure to estimate the apparent vesicle size. Windowing and detrending were used to account for the non-stationarity of the process. We also discuss possible biases and caveats of the method and propose a nested model for capacitance step estimation as a possible enhancement.

Using this analysis on a test dataset, we show that the apparent quantal vesicle size estimators are similar to the real size of a single vesicle, suggesting a complete statistical independence of individual vesicles. The preliminary data analysis therefore does not speak in favour of the compound fusion hypothesis for the mature mouse inner hair cells.