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POSTER PRESENTATION

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Model-based prediction of maximum pool size in the ribbon synapse

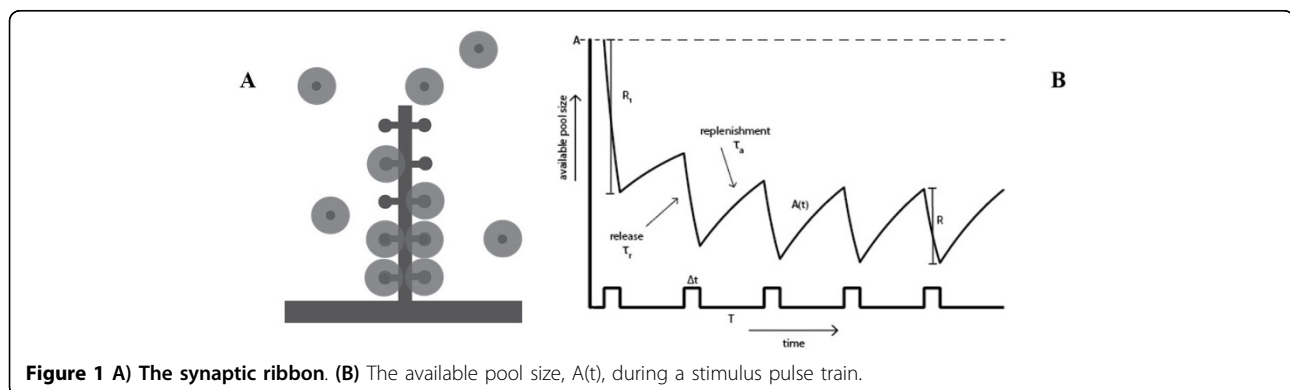
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The synaptic ribbon is a specialized structure in photoreceptor neurons that tethers vesicles prior to release (Figure 1A). When a cell is stimulated, vesicles are released from the ribbon and later replenished from the population of mobile vesicles in the synaptic terminal. A train of depolarizing pulses causes the ribbon to alternate between periods of release (lasting $\Delta t = 25$ ms) and replenishment (lasting $T = 50$ ms), which occur on estimated timescales of $\tau_r = 5$ ms (for release) and $\tau_a = 815$ ms (for replenishment). After the first few pulses, the system approaches a limit cycle, and the amount of vesicles released on each pulse converges to a limiting value, R (Figure 1B). This can be used to determine the maximum available pool size on the ribbon, A . The standard method for estimating A is to measure the rate of replenishment in the limit, and then back-extrapolate from the cumulative release plot to obtain the available pool size at the start of the pulse train [1]. When comparing pulse trains of

different strengths, this method yields substantially different values for A , a somewhat paradoxical result. Back-extrapolation assumes, however, that the replenishment rate is constant, even though it is thought to be proportional to the available space on the ribbon [2].

We developed a model-based approach to estimate A from the limiting release R . We modeled the rate of release (resp. replenishment) to simply be proportional to the number of vesicles on the ribbon (resp. vacant ribbon sites), and using the measured timescale τ_r (resp. τ_a). By solving the alternating differential equations, we derived a recurrence relation for the release during each pulse, R_i , which we then solved to obtain a closed form expression for R_i and the limiting release R . Specifically, we found that $A = cR$, where c is a function of $\tau_r, \tau_a, \Delta t, T$, and p , with p a release constant that captures the stimulus dependence of release probabilities, and can be estimated from the first release, R_1 . In contrast to the



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Table 1 Maximum pool size predictions from pulse train data

Stimulus	Estimate for A, from back-extrapolation	Estimate for A, from the model
-10 mV (stronger)	-136.8794 pA	-131.6858 pA
-30 mV (weaker)	-75.1020 pA	-133.6100 pA

back-extrapolation method, our model-based estimate for A was similar across stimulus types (Table 1), while p was much smaller for the weaker stimulus. This suggests that available pool size does not change with stimulus strength; instead, differences in release result from changes in release probability.

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