Modulation of Short-Term Plasticity at a Glutamatergic Synapse

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Short-term synaptic plasticity (STP) mediates basic signal processing tasks, such as filtering, gain control, adaptation, and many more. My laboratory has studied STP at the Calyx of Held, a glutamatergic nerve terminal in the auditory pathway, which is large enough to be voltage-clamped in the 'whole-cell mode', using patch pipettes. STP is highly modulated by second messengers, such as Ca^{++} and diacylglycerol, which may rapidly switch a synapse from facilitation to depression. Such modulators accelerate a process called 'superpriming' - a transition of release-ready vesicles from a 'normally primed' state to a faster, 'superprimed' one (Lee et al. 2013; PNAS 110, 15079). This same process also mediates Post-Tetanic Potentiation by transiently increasing the proportion of superprimed vesicles (Taschenberger et al., 2016; PNAS 113, E4548-57). Such modulation may also underly the rapid switching between 'Brain States'.
Recent experiments on the dynamics of primed vesicles suggest a molecular interpretation of certain aspects of priming. I will discuss these findings and the possibility, that superpriming may be understood in terms of release sites, which can either be empty or else be occupied by a vesicle with a loosely organized release machinery (partially zippered SNARE-complexes), which is in rapid dynamic equilibrium with a tightly organized state (the superprimed one), in which SNARE-complexes are fully zippered. Importantly, these priming stages are rapidly reversible and the distinction between 'phasic' and 'tonic' synapses may reflect differences in their resting occupancy and stability.