Silent Synapse Activation with LTP

Several years ago, two labs reported silent synapse activation in association with LTP (Liao et al., 1995; Isaac et al., 1995). Silent synapses are those at which an NMDA current is identified at +50 mV, but no AMPA currents are observed at –60 mV. Following the pairing of postsynaptic depolarization to –10 mV with 1 Hz stimulation, one may then immediately record AMPA currents. This process is referred to as silent synapse activation.

We have confirmed the appearance of AMPA currents where there were none previously using whole-cell, voltage-clamp recordings. An example of silent synapse activation is shown in A, and the group average from 12 cells is shown in B.

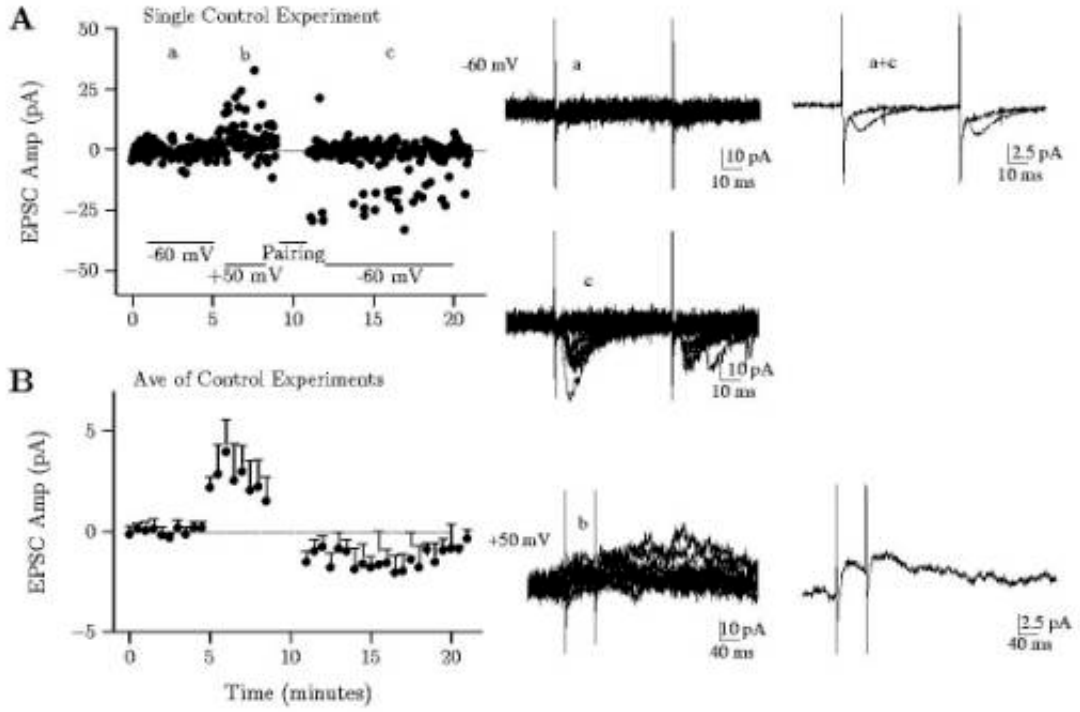

Figure 1. Silent synapse activation. (A) There are no AMPA currents at –60 mV (time a) confirmed in the individual traces to the right. At +50 mV, however, NMDA currents are observed (traces at time b in the bottom row). Pairing postsynaptic depolarization with presynaptic stimulation often results in being able to elicit AMPA currents where there were none previously (right in plot A, and middle row of traces at time c). (B) The average of all 12 cells demonstrates that AMPA currents were present after pairing that were not present at baseline.

We then tested whether the expression of the decremental potentiation that we refer to as ITP also involves silent synapse activation. Those results are quite exciting, but are not published yet and thus cannot be revealed here.

We are not sure whether silent synapse activation indicates a postsynaptic locus for either ITP or LTP expression. Others have interpreted silent synapse activation as a postsynaptic process (Isaac et al., 1995; Liao et al., 1995); however, others have suggested that it occurs through a presynaptic phenomenon (Tsien et al, 2000). Several of our observations also suggest that presynaptic mechanisms may contribute to silent synapse activation. Thus, we are not yet certain what silent synapse activation means in terms of the synaptic locus of expression for either ITP or LTP.

References

1. Isaac JT, Nicoll RA, Malenka RC (1995) Neuron 15(2): 427-434.
2. Liao D, Hessler NA, Malinow R (1995) Nature 375(6530): 400-404.
3. Kasten MR, Schulz PE. Silent synapse activation correlates with sustained but not decremental long-term potentiation. Submitted.
4. Kasten MR, Schulz PE. Evidence for a presynaptic contribution to the activation of silent synapses. In Preparation.