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Modeling of potentiation as cascaded gated processes; relevance to learning and seizure

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The neuron has elemental functionalities such as voltage-gated pores and allosterically-gated enzymes. Such functionalities are cascaded in the neuron resulting in complex functionalities. Such a functionality is potentiation. Potentiation is characterized by an excitation frequency/excitatory-postsynaptic-potential (EPSP) slope relationship. The basis of potentiation is thought to be the same as that of brain seizure and learning. I have reduced these gated elemental functionalities with the "Halfgate" device (fig 1). The behavior of the Halfgate is determined by several inputs. There is one output. The Halfgate-Set is a combination of sensors providing inputs to the Halfgate, an actuator receiving an output from the Halfgate and the Halfgate. The actuator modifies a single material in a single location. The "Den", which models biological potentiation, is composed of Halfgate-Sets mimicking concentration gated pores (See Fig 1). Long-term and short-term memories are embodied in the concentrations of solutes. The Den model exhibits frequency/slope behavior like that seen experimentally. In learning simulations, employing a monolayer of Den-based neurons, challenge-induced misfiring of incidental neurons was scored. Long-term memory was demonstrated: misfiring decreased regarding each successive session-start. Short-

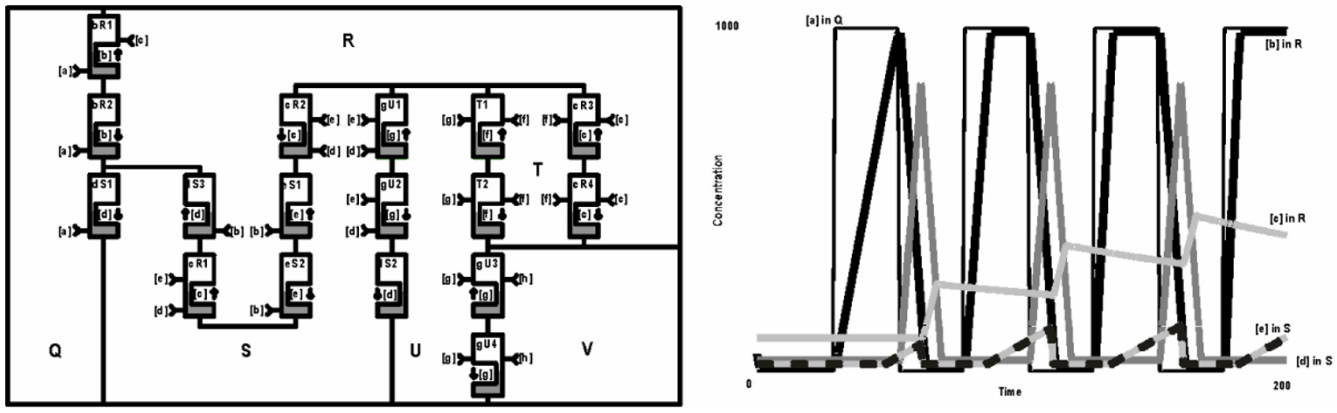

Figure 1
Schematic. Potentiation is modeled with Halfgate-Sets (rectangles with indentions), chambers (Q-V) and solutes (a-f). Specific solute concentrations (input symbols) influence Halfgates and corresponding actuators change the concentrations of a solute (indention). **Graph**. Concentration [a] in Q chamber (thin line) represents a high frequency input to neuron. [b] in R (heavy black line) shows an increasing slope emulating EPSP. [c] in R (light gray line) embodies memory. [c] in R controls the slope of [b] in R.

term memory was demonstrated: within a session misfiring was reduced. First session misfiring at start 50%, end <1%; second session start 3.2%, end <0.1%; third session start 1.8%, end <0.01%. Simulating recruitment in seizure initiation, specific high frequency patterns of excitation caused >0.1% of neurons to fire continuously. Model neurons containing subunits other than the Den are described. Models of experience-modified potentiation, and environmentally and electrically-modified seizure induction are detailed. Details are given of how microcontrollers can be used to produce task-general model brains composed of randomly interconnected neurons, which are comprised solely of cascaded gated pores.