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CONNECTIONS OF IDENTIFIED INTERNEURONS IN THE LEECH ARISE IN NEURAL NETWORKS TRAINED BY BACK-PROPAGATION.

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Interneurons in model networks generated by the back-propagation algorithm were compared to identified interneurons in the local bending reflex of the leech. Touching dorsal, ventral, or lateral skin causes a localized withdrawal from the stimulus (local bending). Four mechanoreceptors (P cells) with dorsal or ventral receptive fields provide the major input to the reflex. P cells connect to eight types of dorsal and ventral motor neurons via interneurons, of which nine types have been identified. Strengths of P cell to interneuron connections were measured as the peak synaptic potential produced by a standard P cell impulse train. Output connection strengths for two interneurons were measured as the amplitude of synaptic potentials in the motor neurons following fixed depolarization of the interneuron. We trained a model network of four sensory, eight motor, and nine pairs of interneurons using back-propagation to reproduce the amplitudes of synaptic potentials of the motor neurons during the three forms of local bending. The network included known lateral connections among motor neurons, but no constraints were placed on the pattern of interneuronal inputs and outputs. However, following training the model interneurons, like the real ones, received inputs from dorsal and ventral P cells, and connected to all eight motor neurons. Additional biological constraints, including recurrent connections and temporal response properties, can now be used to improve the predictions of the model.

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