Scientists create working artificial nerve networks

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Scientists have already hooked brains directly to computers by means of metal electrodes, in the hope of both measuring what goes on inside the brain and eventually healing conditions such as blindness or epilepsy. In the future, the interface between brain and artificial system might be based on nerve cells grown for that purpose. In research that was recently featured on the cover of *Nature Physics*, Prof. Elisha Moses of the Physics of Complex Systems Department and his former research students Drs. Ofer Feinerman and Assaf Rotem have taken the first step in this direction by creating circuits and logic gates made of live nerves grown in the lab.

When neurons - brain nerve cells - are grown in culture, they don't form complex 'thinking' networks. Moses, Feinerman and Rotem wondered whether the physical structure of the nerve network could be designed to be more brain-like. To simplify things, they grew a model nerve network in one dimension only - by getting the neurons to grow along a groove etched in a glass plate. The scientists found they could stimulate these nerve cells using a magnetic field (as opposed to other systems of lab-grown neurons that only react to electricity).

Experimenting further with the linear set-up, the group found that varying the width of the neuron stripe affected how well it would send signals. Nerve cells in the brain are connected to great numbers of other cells through their axons (long, thin extensions), and they must receive a minimum number of incoming signals before they fire one off in response. The researchers identified a threshold thickness, one that allowed the development of around 100 axons. Below this number, the chance of a response was iffy, while just a few over this number greatly raised the chance a signal would be passed on.

The scientists then took two thin stripes of around 100 axons each and created a logic gate similar to one in an electronic computer. Both of these 'wires' were connected to a small number of nerve cells. When the cells received a signal along just one of the 'wires,' the outcome was uncertain; but a signal sent along both 'wires' simultaneously was assured of a response. This type of structure is known as an AND gate. The next structure the team created was slightly more complex: Triangles fashioned from the neuron stripes were lined up in a row, point to rib, in a way that forced the axons to develop and send signals in one direction only. Several of these segmented shapes were then attached together in a loop to create a closed circuit. The regular relay of nerve signals around the circuit turned it into a sort of biological clock or pacemaker.

Moses: 'We have been able to enforce simplicity on an inherently complicated system. Now we can ask, 'What do nerve cells grown in culture require in order to be able to carry out complex calculations?' As we find answers, we get closer to understanding the conditions needed for creating a synthetic, many-neuron 'thinking' apparatus.'

For the scientific paper, please see: www.nature.com/nphys/journal/v … 12/pdf/nphys1099.pdf .

Source: Weizmann Institute of Science