New analog chip acts just like a nerve cell

It may look like an ordinary computer chip, but the "silicon neuron" is nothing like those that run even the most avant-garde machines.

Two computational neuroscientists have made a new chip that brings researchers a step closer to creating a machine that truly mimics the nervous system. Because the device uses a new type of analog technology, its transistors act like nerve-cell membranes, says Misha Mahowald, a graduate student at the California Institute of Technology in Pasadena. She and Rodney J. Douglas of the University of Oxford in England designed the chip so that its circuits replicate the electrical currents that affect cell membranes and cause nerve cells to fire. They describe the new device in the Dec. 19/26 NATURE.

Mahowald and Douglas are now working out the technical details for putting many neurons onto one chip and interconnecting a series of chips to create "megacircuits" that can model brain function, Douglas says.

In addition, the researchers plan to link the silicon neurons to existing analog chips that mimic sensory nerve cells in the ear (SN: 1/6/90, p.7) or in the retina, Mahowald says.

Scientists currently simulate small groups of neurons by using neural networks, but the computer programs take a long time to run, even on very powerful machines. "[Silicon] neurons could solve these kinds of problems very easily," says Douglas. Even with thousands hooked together, silicon neurons should work at least as fast as the nerve cells they emulate and with little power consumption, he says.

Douglas and Mahowald hope to make an easy-to-use system that neurobiologists can put to work testing ideas about neural circuitry. "We'd like to make a cheap, fast tool for the 'neuroscientist in the street,'" Douglas says.

Because even a network of silicon neurons operates in real time and requires little power, Douglas thinks roboticists may find these neurons more useful than artificial intelligence computers for controlling robots that must maneuver on their own.

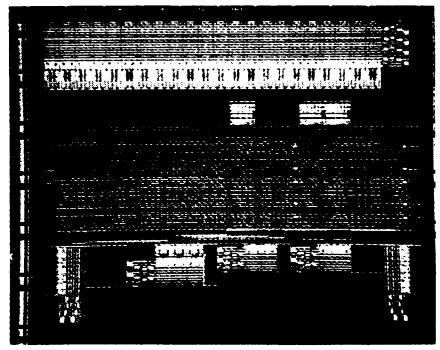
Computer chips typically use digital signals to operate; thus, a signal is either on or off, but never partly on. Analog devices need less power to run, and they operate very rapidly. Their signals exhibit a continuum of responses, so they lack the precision of their digital counterparts. "But a very important characteristic of the brain," notes Douglas, "is that it doesn't do things very precisely."

For years, Douglas has studied the electrical properties of brain cells involved in vision. His research provided the details needed to design the circuitry in the silicon neuron. "It all rests on the fact that transistors in this subthreshold regime have physical characteristics that are similar to the physical characteristics of a real membrane," Douglas says.

For example, in a nerve cell, the membrane serves a function similar to the gate in a transistor. To conduct a current, a transistor lets electrons through its gate. Likewise, a cell membrane's current results when channels in the membrane open briefly to let ions move into and out of the cell. The types of membrane channels and the rate at which they open result in the different impulses that let nerve cells communicate with each other.

Douglas and Mahowald designed the silicon neuron so that each of its circuits represents a different kind of membrane channel. With these circuits, they can recreate the various types of currents that make a nerve fire.

According to Mahowald, several neurobiologists have had trouble distinguishing between the patterns generated on oscilloscopes by real neurons and their silicon counterparts.



Mahowald/Caltech

Computer image shows the layout of a five-neuron silicon chip. Colors represent various materials to be layered onto the silicon.

"It comes closer than anything I could ever imagine," says Oxford neurobiologist Kevan A.C. Martin. "It does in an electronic way what a biological neuron is doing. That's tremendously exciting."

– *E. Pennisi*

Firstborn twin runs higher AIDS risk

The twin that braves the birth canal first faces the greater risk of infection with mother's AIDS-causing human immunodeficiency virus (HIV), a new study indicates.

A decade after the first AIDS cases surfaced, scientists still don't completely understand how the deadly virus passes from mother to child. Some studies have hinted that mothers can pass HIV to an embryo or fetus in the womb or during delivery. Others have suggested that newborns can catch HIV from infected breast milk (SN: 8/31/91, p.135). The new study supports the theory that some babies contract HIV infection during passage from the womb.

AIDS researcher James J. Goedert of the National Cancer Institute's Viral Epidemiology Section and his colleagues obtained data on 66 sets of mostly bottle-fed twins born to HIV-infected mothers in nine countries. Goedert's team collected information on birth order, delivery method and whether or not the infants showed signs of HIV infection. Babies were at least 6 months old at the time of data collection.

Among the firstborn twins, 50 percent of those delivered vaginally and 38 percent of those delivered by cesarean section had HIV infection, the researchers report in the Dec. 14 LANCET. The twin who lagged behind had a better chance of escaping the viral threat: With either delivery method, 19 percent of these babies had HIV infection.

Goedert says these findings suggest that vaginal delivery can put infants at high risk of contracting their mother's HIV infection. He speculates that the trip through the cervix and vagina may expose a firstborn twin to large amounts of bloody, HIV-laced secretions. By the time the second twin gets to the birth canal, he adds, the sibling has cleared out much of the bloody fluid – and perhaps the HIV as well.

Goedert suspects that cesarean sections are risky for firstborn twins when doctors wait too long after the protective amniotic sac breaks and the baby nearest the cervix is exposed to an influx of maternal HIV. As in vaginal births, the first twin delivered in a cesarean section is the one closest to the cervix.

The researchers say their data also hint that genetics may play a role in a baby's vulnerability to HIV infection.

The new findings await confirmation in laboratory studies and larger clinical trials, notes Howard L. Minkoff, an AIDS researcher at the State University of New York Health Science Center at Brooklyn. Furthermore, scientists still don't know whether solo babies, who also endure traumatic, bloody deliveries, run the same HIV risk as firstborn twins. "It's early data," Minkoff says.

However, notes Goedert, if further studies clearly establish a delivery-related HIV threat, then scientists can begin working on methods of preventing mother-to-baby HIV transmission, potentially saving thousands of infants worldwide. – *K.A. Fackelmann*