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Note: Quotations from many more who know astronomy best will appear later.

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PATHS OF PAIN

Breaking the neural codes

Five means of messaging the mind postulated by nerve researchers

by Christopher Weathersbee

If you touch the lighted end of a cigarette, you are going to hurt.

Usually, the nerves get the blame, or credit, since the pain causes withdrawal and prevents further burning. Most people think that pain travels up a nerve from offended hand to the brain, where it is noticed and acted upon.

Actually the nerve does not transmit pain. It transmits a coded message which the brain is capable of interpreting as pain.

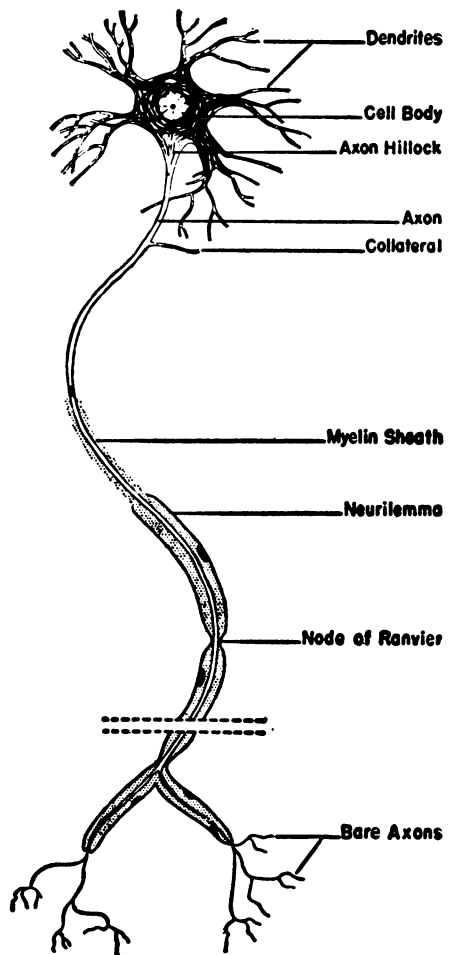
Scientists are very interested in cracking this neural code. Understanding of it could lead to understanding of how the brain functions. It is almost true that the rest of the body exists to support the brain, yet very little is known of this awesome organ's operations. Some of the latest ideas about the language of the nerves and brain were presented at the 105th annual meeting of the National Academy of Sciences.

Dr. Theodore H. Bullock of the University of California Medical School says there are three methods suggested at the moment whereby the nerves can transmit their coded messages.

The most familiar is the neural impulse. This is analogous to telephone communication. Nerve fibers are spliced together to form something like long wires leading from the finger, for instance, to the brain. In a way not at all clearly understood, touching something stimulates the end of the wire.

The stimulation causes the movement of a group of light metal ions into and out of the nerve cell. These ions are electrically charged atoms of sodium, potassium, and calcium. The movement of one group causes similar movement in the next group of ions up the nerve fiber. Like falling dominoes, the groups of ions all the way to the brain jostle each other into motion. In this way an impulse is quickly carried up the fiber.

A second method of transmission is called decremental transmission, comparable to radio transmission. Stimulation of some kind, acting on the nerve ending, produces a flash of elec-



Mary Brazier and Williams & Wilkins, publishers
Neuron: encoder as well as path.

trochemical activity. This flash causes weaker activity a little farther up the fiber, which weaker activity causes even weaker activity even farther up, and so on.

In this way a signal is transmitted which, like radio, quickly gets weaker the farther it gets from the source. (Impulses transmitted by the wire method reach the other end essentially undiminished in strength.) Decremental transmission is not believed capable of carrying more than a few hundredths of a millimeter before the signal fades into the ever present garble of background noise.

The third method of transmission, given shelf space by scientists only as

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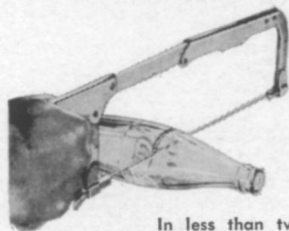
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a theoretical possibility at the moment, might be chemical. This would be like the mail. It would involve the physical transport along the nerve fiber of packets of chemicals which would stimulate or inhibit some action upon arrival at the other end.

Like the mail versus telephone and radio, this kind of transmission would be much slower than impulse or decremental transmission.

A single impulse carries comparatively little information to the brain. In some cases of course the brain has a nerve labeled eye, or ear, or hand and so on. In this case a single impulse will carry only the information that the eye has seen, the ear heard, the hand touched. (It will not inform the brain as to what has been seen, heard or touched.) Often nerves are not labeled with any degree of exactness at all, in which case the single impulse carries even less information. The nerves therefore must modulate their signals into more informative codes.

Dr. Bullock says there are presently five codes besides the uninformative single impulse. (The impulse often is referred to as a spike because of the sharp peak it records on monitoring devices.) Often different codes are used by two nerves lying side by side.

One system uses something like Morse code. There may be a long burst of impulse firing followed by a short burst, then by a medium length burst, then by another short burst, then by a single spike.

Another system fires a series of single impulses but varies the interval between spikes. Impulses coming close together mean one thing, further apart another thing, and a mixture of close and far still another thing.

The third code uses intervals between single spikes of only two lengths, short and long. This code varies the ratio of short to long intervals in a given cycle of impulse firing.

At least two nerve fibers are needed for the fourth code. In this system single impulses are fired at constant intervals in both fibers. The signals are at the same frequency and therefore the impulse in one nerve always lags behind the other by a fixed amount. Stimulation of one of the nerves causes the premature firing of an impulse, and when the steady firing is resumed the fixed lag has changed. The amount of this change is believed to convey information to the brain.

The final code depends on changing the probability that a fiber will fire during a given cycle of firing. At one point the fiber may fire five out of a possible ten times, at another it may fire nine out of ten times, and at another, fire only once.

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